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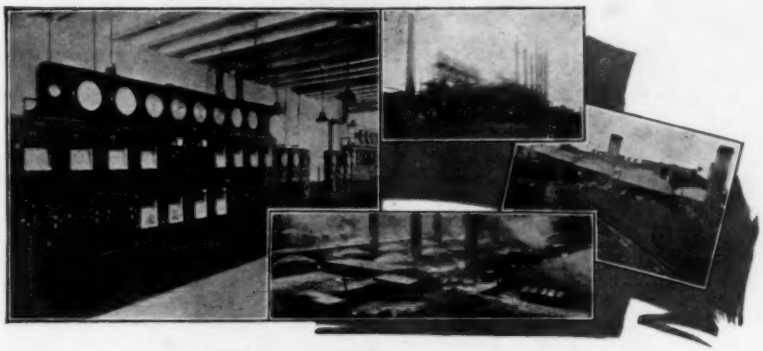

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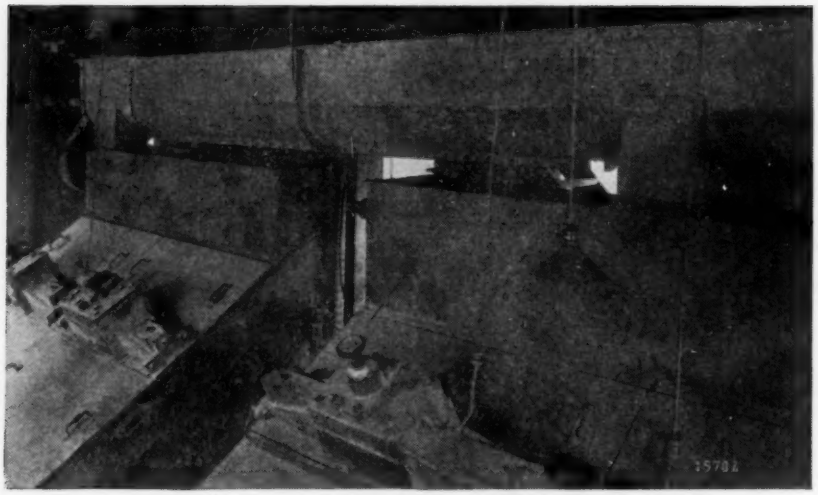

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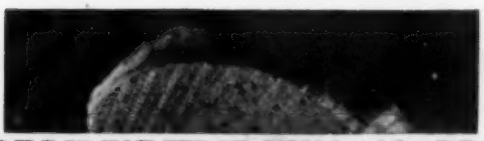

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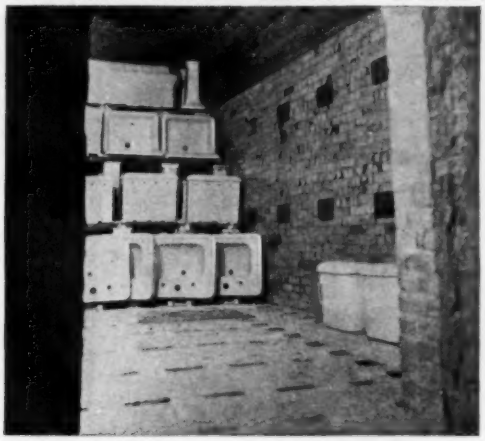

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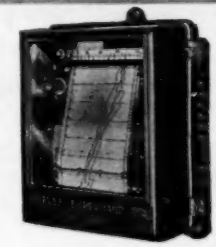

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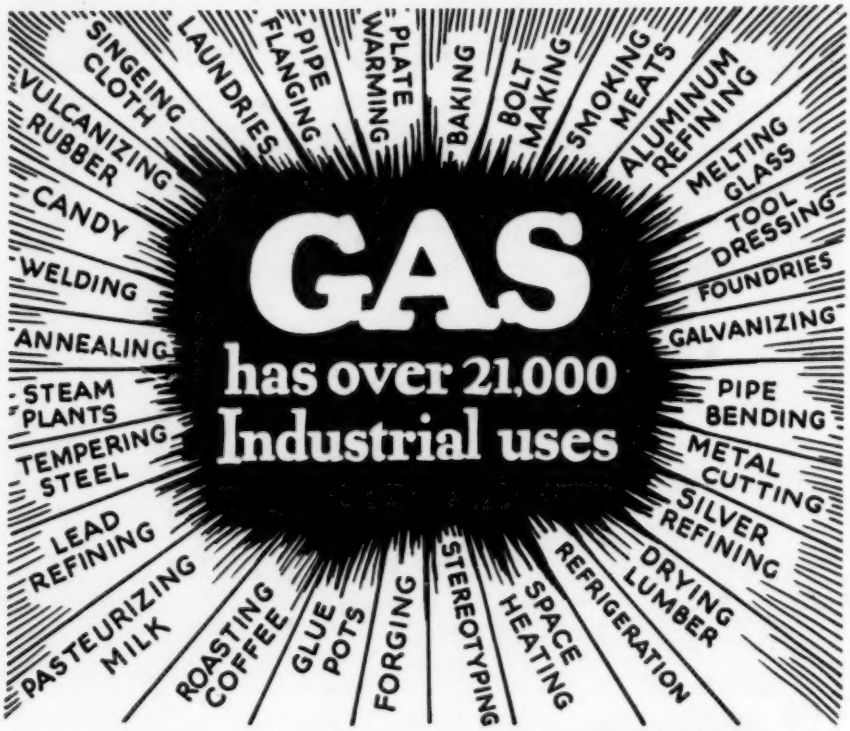

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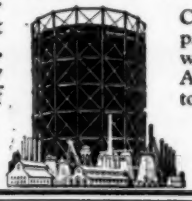

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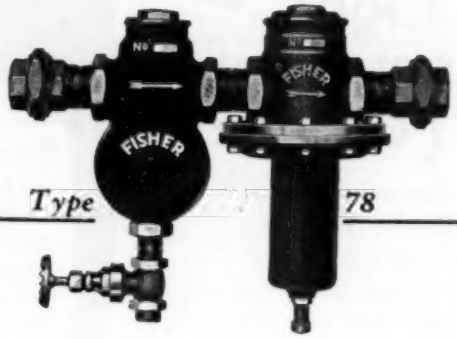

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Table of Contents

APRIL, 1928

The Journal

The Influence of Different Feldspars on the "Freezing" Behavior of Cones —Orton Jr. and Krehbiel 215
The Effect of Temperature on the Optical Properties of Kaolinite—McVay 224
Labor and Air-Power Cost of Sand-Blasting—Stehman 227
Physical and Chemical Properties of Oils and Problems of Their Removal —Guernsey 235
Use of Manganese in the Manufacture of Face Brick—Seil and Heiligman 241
The Effect of Incorrect Die Adjustment upon Drier and Kiln Losses—Alt 249
The Design of Hollow Tile Dies—Greaves-Walker 254
Some Experiments on Terra Cotta Slips—Hill 260
The Relative Importance of Errors of Sampling and Measurement in Ceramic Research—Westman 264

Ceramic Abstracts 199

The Bulletin

Editorial

Design in Printed Table Ware—Binns 75

Papers and Discussions

Recent Developments in Firebrick Testing—Saunders 78

Activities of the Society

Ceramic Manufacturing Abroad 83
New Members Received from February 1 to March 1 94
Personal News from Members of the Society 96
Constitution and By-Laws of the AMERICAN CERAMIC SOCIETY 96
Book of Standards Table of Contents 106
Publications of the AMERICAN CERAMIC SOCIETY Out of Print 109
Ceramic Exhibit at Secretary's Office 109

News from the Local Sections

Management Meeting in Pittsburgh 110
Pittsburgh March Meeting 111
California Section Officers 111
St. Louis Section Meeting 111

Notes and News

Notes from the Ceramic Schools 112
American Refractories Institute Meeting 113
Materials Handling Division, A.S.M.E. 113
Lime Convention to Discuss Critical Conditions 113
Clay Products Foremen's Short Course 114
A.S.M.E. Special Research Committee on Fuels 114
Major Smokestacks in Utah 116

Calendar of Conventions 117

Advertisers' Index 29

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THE INFLUENCE OF DIFFERENT FELDSPARS ON THE "FREEZING" BEHAVIOR OF CONES[1]

By Edward Orton, Jr. and J. F. Krehbiel

ABSTRACT

The term "freezing," in ceramic parlance, means the increased resistance to viscous fusion, which ceramic bodies often show when their heat treatment is interrupted by chilling or the temperature is held static too long and not allowed to progress upward at the usual or proper rate. A body so treated often becomes distinctly more refractory and cannot be softened to viscous fusion without use of a higher temperature than would otherwise have been necessary. In this condition, it is said to be "frozen." This freezing behavior may occur in the firing of cones as in other ceramic products, and, because of the use to which they are put and their shape which facilitates accurate comparisons, is more serious in its consequences and more easily detected than in other ceramic products.

The present study was undertaken (*a*) to get some definite quantitative measurements of just what this lag in fusion amounts to under a given set of conditions, (*b*) to determine whether it is a peculiarity due to some one ingredient or combination of ingredients, or whether it is a generic quality applying to all ceramic mixtures of a given range, and (*c*) to get any new light that could be had as to the ultimate nature or cause of the phenomenon.

The amount of the lag has been quantitatively determined for cone 10 as furnished by the Germans and our own factory, and the influence of different feldspars and clays in producing this lag has been experimentally studied. Different feldspars are shown to produce characteristic effects. No important light is thrown upon the ultimate cause of the phenomenon.

I. Reason for the Investigation

There has been complaint for some years past from certain classes of users of Standard pyrometric cones that some members of the cone series gave trouble by freezing, while German cones of corresponding numbers were said not to exhibit this phenomenon. The complaints came from those industries in which ware is dense and bulky and nests solidly in a sagger thus requiring slow firing and "heat soaking" to secure even distribution of the temperature throughout the mass, and especially from industries such as the manufacture of abrasive wheels where small differences of hardness and vitrification are of great importance in the product.

Coming in but occasionally, these complaints were not at first considered as representing a general defect. It was thought that the differences complained of depended largely upon peculiarities of the firing treatment or other local reasons. It was not until February 1927 that a coördination of the technical problems of a group of manufacturers showed that this matter was giving trouble to all the members of the

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Refractories Division.)

group. The fact that other industries were using the same cones with satisfaction for a long time obscured the genuineness of the ground for complaint.

II. Verification of the Existence of the Freezing Effect

A grinding wheel company, which will be designated hereafter as Plant *A*, sent in eight pats of cones which had come through its kilns. Four of these contained cones 8, 9, 10, and 11 of Standard series on each pat and the other four contained German cones of the same numbers. The latter had gone down properly in order and showed a good glazed appearance. The former had not gone down properly and showed a dead or dull surface. With this material was sent its kiln record and recording pyrometer curve-sheet, and later at our request, fifteen No. 10 cones each of the Standard and German makes, from the same original packages as those submitted from the kiln tests.

The kiln record showed that the temperature had been carried up to 1195°C, and then held around that point fluctuating from as low as 1182°C to as high as 1204°C, for a period of 21 hours. The American cone 10 was frozen, *i.e.*, it was not down as it should have been, and presented a more or less harsh or dry appearance on the surface. The German cone 10 was not frozen, and had gone down as it should and was glossy and smooth on the surface.

First Comparison A frozen Standard No. 10 cone detached from one of the pats furnished by Plant *A*, was tested in the platinum electric furnace, against a raw cone of the same batch, which happened to come from an old lot made several years ago. A cone of the present output of cone 10 was included in the comparison.

Firing 168

Conditions: Temperature increase was somewhat more than 20°C per hour in the early parts of the firing and very accurately 20°C per hour for the last 50°C.

Results:	Frozen cone 10 (Standard)	1295°C
	Raw cone of same lot	1251°C
	Raw cone of present output	1258°C

The check between the old lot and the present output of cone 10 (7°C) was considered fair. The frozen cone required substantially 40°C more temperature to bring it down, and presumptively, the long "soaking" treatment (21 hours at 1195° in a commercial kiln) was responsible; at least it bore out the complaint of the users.

Effects of Soaking under Various Conditions The heat soaking at Plant *A* gave a result of 1204°C maximum, as measured on their pyrometer. The preceding experiment, at a steadily progressive rate of 20° per hour, in clear air, electric furnace conditions, gave a result of 1255°, or 51°C higher.

This suggested a series of soaking treatments at different temperature levels with accurate measurement of the falling points after each. This was executed in Firings 169, 170, 171, and 172. Firing 168 carried out with a steady temperature increase of 20° per hour gave 1258° as the correct falling point of the present output of cone 10.

Firing			Cone 10 fell at		
169	Soaked at	1220°C	9½	hours	exposure
170	" "	1230°C	3	"	"
172	" "	1240°C	2	"	"
168	No soak	1258°C	0	"	"

These data are plotted in Fig. 1.

This illustrates quantitatively that the Standard cone 10 can be "soaked" down, and that the length of the soak depends on the temperature plane at which it is carried out, always assuming that it is within the critical temperature range for the cone. Of course, it would never melt down at a temperature 100°C lower.

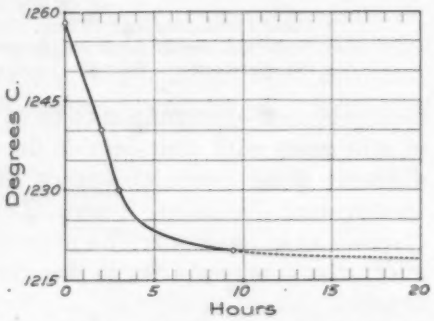

FIG. 1.—Curve showing approximate length of soaking periods in hours of cone.

Comparison of German 10 and Standard 10

The check on German 10 and Standard 10 leaves nothing to be desired, as far as the behavior of the German and American cones is concerned, when fired under ideal conditions. A direct comparison at 20°C per hour gave these results:

German 9 (recent official importation)	1244°C
German 10 from Plant *A* lot	1254°C
Standard 10 from Plant *A* lot	1253°C

Two raw German cones (cone 10) and two raw Standard cones (cone 10) (both from Plant *A*) were heated in the electric furnace for 20 hours at 1179–1187°C (Firing 176). At the end they had definitely started to bend, though but very little. These cones were now cooled down and placed in new firings as follows:

Firing 177
20° Per Hour to the Finishing Point

German 10 without freezing treatment	1260°C
German 10 with freezing treatment (176)	1260°C
American 10 without freezing treatment	1257°C
American 10 with freezing treatment (176)	not fused (one-third over)

This test was duplicated in Firing 178, with very similar results. The contention made by Plant *A*, that the German 10 does not freeze

is borne out as far as the condition of this test shows. Also the American Standard does freeze even in the relatively short treatment in the electric furnace.

Relation between Freezing in Commerical and Laboratory Conditions

The temperature was not pushed up till the frozen Standard cone was down as the comparative conditions of the two first to fall could not have been studied subsequently. But in Firing 168, this difference has

Firing 179
20° Per Hour to the Finish

Frozen Standard cone 10 from Plant *A*	Not fused
Standard cone 10 (same lot) frozen at laboratory	1269°C
Standard cone 10 (same lot) not previously fired	1255°C

been previously determined to be 44°C. It is clear that factory freezing in kiln gases with considerable fluctuation of temperature, is quite a different thing from laboratory soaking in pure air at a constant temperature just below fusion. The latter is, strictly speaking, not a "freeze" at all. It is merely a prolonged "soak." The increased freezing effect in commercial firing is therefore entirely natural and to be anticipated.

III. Influence of the Ingredients of German and American Cones upon the "Freezing" Effect

Since cone 10 of both German and American factories is made upon substantially the same formula, using the same four minerals, flint, feldspar, kaolin, and calcium carbonate, and in both cases securing materials of the highest degree of purity commercially obtainable, it seems that this difference in behavior is likely to originate in the chemical or mineralogical structure of some one of these four ingredients. Since quartz and calcium carbonate are simple compounds, obtainable in very pure form, it seems unlikely that the observed difference between the two cones would be attributable to either of these. In the case of feldspar and kaolin, there is much greater individuality between different sources of supply, and much greater difficulty in securing consecutive lots of the same quality from the same source. Of the two, the feldspar is the more complex and constitutes the greater proportion in the cone mix. Hence, it was thought that the feldspar would be the most likely cause of the difference in freezing behavior. It was, accordingly, taken first for investigation.

The Feldspars

Twenty or more different samples of feldspar were collected from United States, Canada, and Sweden. All represented producing mines

or openings which had produced commercially at one time. The mineralogical structures were studied carefully. Some, which were obviously widely different from the Swedish feldspar used in the German cones or the Genesee Feldspar Company's product from their mine at Hybla, Ontario, used in the Standard cone, were set aside. The rest were fairly similar to the two varieties in commercial use and were tested in the kiln to develop firing characteristics and color. It was thought for a time that the perthitic structure which indicates interspersion of growths of the albite crystal in thin laminae along the cleavage planes of the orthoclase or microcline, might give a clue to the difference in behavior. This idea has been temporarily given up, however, as the perthitic structure does not seem to correlate with the fusing behavior or solvent power of the feldspar when used as a flux. If any relation exists it will require more refined experimental methods to prove it.

TABLE I
Chemical Analyses

	Rörstrand Sweden	Conn. Middletown Conn.	Isco Keystone S. Dak.	Derry Buckingham Quebec	Hybla Ontario
H_2O at 105°C	.19	.05	.02	.00	.20
Ignition loss	.33	.38	.42	.33	.51
SiO_2	65.56	65.18	64.13	64.93	66.82
Al_2O_3	18.53	18.63	18.85	18.50	18.01
Fe_2O_3	.16	.30	.12	.28	.22
TiO_2	.01	.01	.01	.01	.01
P_2O_5	Trace	.118	.595	.031	Trace
CaO	.02	.04	.01	.07	.52
MgO	.19	.07	.04	.05	.27
K_2O	11.83	11.89	12.76	13.25	10.00
Na_2O	2.96	2.98	2.55	2.18	3.48
Totals		99.648	99.505	99.631	

Molecular Ratios and Combining Weights

	Swedish	Conn.	Isco	Derry	Hybla
K_2O	.70429	.71459	.76237	.78915	.5964
Na_2O	.26717	.27151	.23100	.19685	.3137
CaO	.00196	.00401	.00101	.00700	.0521
MgO = 1.0 Ro	.02658	.00989	.00561	.00700	.0378
Al_2O_3	1.16658	1.03180	1.03793	1.01545	.9898
Fe_2O_3	.00559	.01059	.00421	.00979	.0080
SiO_2	6.11421	6.13711	6.00297	5.77895	6.2420
TiO_2	.00070	.00070	.00070	.00070	.0007
P_2O_5	trace	.00469	.02353	.00123	trace
	Swedish	Conn.	Isco	Derry	Hybla
RO	1.00000	1.00000	1.00000	1.00000	1.00000
R_2O_3	1.17217	1.04239	1.01214	1.02524	.9978
RO_2	6.11491	6.14250	6.02720	5.78088	6.2427
Molecular Weight	558.4	562.9	558.8	557.8	560.7

Analyses Analyses were run, independently of the figures furnished by the producers, on five samples. The work was done by D. J. Demorest,[2] and the results are given in Table I.

[2] Dept. of Metallurgy, Ohio State University.

These feldspars form a series, with the Swedish and the Hybla forming the two extremes.

Hybla Feldspar The Hybla feldspar is evidently a little less pure than the others containing (*a*) a little more silica either as free quartz or in solution in the feldspar molecule, (*b*) a little more albite, either free as perthitic inclusions or in solid solution in the feldspar molecule, and (*c*) a larger amount of anorthite or other lime- and magnesia-carrying minerals, although the amount of these is very small at the highest.

Swedish Feldspar In appearance it is a brownish gray, or a very light fawn color. A very fine crystal sample shows perfect cleavage lines and is mottled with decided dark and light veins, the so-called perthitic structure. It is apparently free from quartz or mica.

Derry Feldspar The sample at hand is an equally fine crystalline structure, grayish in color with very sharp lines of cleavage and some streaks of its coloration. The perthitic structure is visible but much less pronounced and of a larger mesh. Its structure checks with the lower soda content which the analyses disclose.

Isco Feldspar This is a very light gray crystal showing well-developed cleavage and a very pronounced perthitic structure which shows signs of quartz inclusions.

Connecticut Feldspar This is very similar in appearance to the microclines of Virginia and North Carolina. It is white in color and breaks only partly on the lines of cleavage. Its color makes it difficult to see the perthitic structure which it probably has. Some of the samples furnished were very pure while others contain notable inclusions of quartz and mica.

Fusibility Samples of Hybla and Swedish feldspars were ground carefully to equal fineness by screen test, and made into cones and fused. The touching points were Hybla 1184°C, and Swedish 1209°C. This accords with previous studies, in that free silica is known to reduce the fusing point of a pure orthoclase, and also that a mixture of albite with orthoclase reduces the melting point of either.

The Swedish and Hybla feldspars were heated separately in Denver crucibles to a semifluid melt and chilled in cold water. Neither was reduced to a clear glass; both were opaque white glasses. Being ground to fine powder in an agate mortar and made into cones, the two feldspar glasses now gave Hybla 1143°C, and Swedish 1153°C.

Thus it appears that the fusion point is reduced 56° in the case of the Swedish and 41° in the Hybla, while the difference between them in the raw state, 25°C, is reduced to 10°C after fusion. Following this, firings were made of cones of Connecticut, Isco, and Derry in com-

parison to Swedish. The hardest of these, the Derry, was only one-fourth over when the Swedish touched. The Connecticut was nearly as fusible as the Swedish, and the Isco a few degrees harder than the Connecticut but softer than the Derry. These firings bear out the contention that the orthoclase formula, which the Derry most closely approached, is more infusible than a mixture of orthoclase and albite, and the fusibility of the five are arranged in the same order as the increase in potash in the analyses.

Feldspars Compared in Body Combination

A series of No. 10 cones was now made up to determine what relative amount of freezing reaction would be developed by the following combinations:

Hybla feldspar and Florida kaolin
Hybla feldspar and Zettlitz kaolin
Swedish feldspar and Florida kaolin
Swedish feldspar and Zettlitz kaolin

The flint and calcium carbonate were the same throughout, being that used in the Standard cones.

Inasmuch as the principal comparisons are between the German materials and the American, the Swedish feldspar-Zettlitz kaolin cone batch was adjusted until it closely matched the Hybla feldspar-Florida kaolin cones. To accomplish this the alumina silica content had to be slightly altered. In the case of the other feldspars, they were substituted weight for weight into the Hybla feldspar-Florida kaolin cone mixture, and consequently slight difference in fusing point of the resulting cones was created. These variations in melting points were not enough to be of importance.

TABLE II

(1) Swedish Feldspar and Zettlitz Kaolin

Firing	Raw (°C)	Frozen (°C)	Difference due to freezing (°C)
224	1269	1271	+2
225	1273	1274	+1
226	1274	1275	+1
Mean	1272	1273	+1

(2) Swedish Feldspar and Florida Kaolin

Firing	Raw (°C)	Frozen (°C)	Difference due to freezing (°C)
205	1252	1259	+7
206	1254	1259	+5
207	1254	1259	+5
Mean	1253	1259	+6

(3) Hybla Feldspar and Zettlitz Kaolin

Firing	Raw (°C)	Frozen (°C)	Difference due to freezing (°C)
216	1240	1264	+24
217	1239	1261	+22
218	1238	1262	+24
Mean	1239	1262	+23

(4) Hybla Feldspar and Florida Kaolin

Firing	Raw (°C)	Frozen (°C)	Difference due to freezing (°C)
205	1265	1279	+14
206	1268	1282	+14
207	1265	1281	+16
Mean	1266	1281	+15

In all the comparisons given in Table II, raw cones were given a freezing treatment of 20 hours at a point just below their deformation

point, and then fired to fusion against new cones of the same lot at a rate of 20° per hour. No consideration need be given to their agreement or disagreement with the regular fusing point of cone 10, as the small lots and the slight variations in body proportions were certain to bring in some differences. But the point to bear in mind is the entire comparability of each set as tested in the raw against the frozen form.

Assembling terms, we find that the Swedish feldspar in combination with Zettlitz kaolin has produced, or is associated with a freezing effect of +1°C, with Florida kaolin +6°C. Hybla feldspar in combination with Zettlitz kaolin has produced or is associated with a freezing effect of +23°C, with Florida kaolin +15°C.

In view of the triple repetition of each test and the extremely good general concurrence, the small variation between the tests composing each series, and the minutely exact control of both temperature measurements and heat control, both in the freezing treatment and the subsequent fusion, it seems difficult to doubt that this difference in the freezing tendency introduced by the Hybla feldspar is a real thing, and that it is quantitatively measured, for this set of conditions at least, as about 15°C when using Florida kaolin and 20°+ when using Zettlitz kaolin.

Comparisons of Other Feldspars

In view of the conclusions reached in the preceding paragraph it became of interest to know whether other feldspars falling between the Swedish and the Hybla in their characteristics would exhibit the freezing effect in a graded series or whether their freezing effect, if any, would be erratic and without apparent reference to their composition. Accordingly, the three other feldspars whose analyses have been given earlier in this paper were made up into cone 10 in the same way and with the same precautions as was observed in the work thus far reported and were submitted to the 20-hour freezing treatment. The frozen cones were then tested against raw ones of the same make at the 20°C per hour rate in the electric furnace. The results are given in Table III.

TABLE III

Firing		Fusing Point Raw (°C)	Fusing Point Frozen (°C)	Difference due to freezing (°C)
244	Connecticut feldspar and Florida kaolin	1269	1274	+5
245	Isco feldspar and Florida kaolin	1270	1275	+5
246	Derry feldspar and Florida kaolin	1264	1273	+9

This experiment seems to indicate that each feldspar has a certain characteristic or habit in regard to its tendency to be affected by the freezing treatment. Two of them are very like the Swedish. The third is more affected than the other two, but less than the Hybla.

General Conclusions

It has now been shown by the preceding data that:

(1) In cone 10 produced by the Germans and by the Standard Pyrometric Cone Company, which check each other admirably under normal firing conditions, divergence in fusing behavior is exhibited when they are subjected to a freezing treatment.

(2) This divergence is quantitatively measured under the narrow set of conditions used in the electric furnace. Some data are shown indicating that the divergence is increased several times under the more drastic freezing conditions occurring in commercial kiln firing.

(3) It is shown that the so-called freezing effect occurs more seriously in the Hybla feldspar and to a very much less degree in the Swedish feldspar, and that the effect of the kaolin used with the feldspar has some influence in the amount of freezing effect produced.

(4) It is shown that in the case of the three other feldspars tested, which fell between the Swedish and Hybla feldspars in composition and other characteristics, one falls between them in the matter of the freezing effect and the other two check the Swedish feldspar.

(5) The real nature of the freezing effect is not disclosed in any of these studies. Such tentative efforts as were made to develop the cause, either by microscopic studies of minute grains or by thin sections, developed no information of a promising nature. No evidence of crystallization in the frozen cones could be found. Such differences as were observable related principally to the degree of completeness with which the feldspar particles had dissolved to form a glass. The divergence in this respect seems at variance with the degree of freezing attained.

(6) In another paper from this same laboratory, submitted by two other investigators, the same problem has been attacked from a very different standpoint and practical results of a high degree of value have been attained.

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THE EFFECT OF TEMPERATURE ON THE OPTICAL PROPERTIES OF KAOLINITE[1]

By T. N. McVay

ABSTRACT

Euhedral crystals of kaolinite were heated to various temperatures, draw trials made at frequent intervals, and the effect of temperature was studied microscopically. The results obtained indicate three classes of kaolinite: (1) the natural kaolinite, (2) the uniaxial form produced at 625°C, the metanacrite of Rinne, and (3) the change of the metanacrite into what is probably mullite and glass at 1450°C.

Raw Material

The natural kaolin crystals were obtained through the courtesy of W. S. Bayley, Department of Geology, University of Illinois and were a part of those found at the National Belle Mine in Colorado. They are rather unique since as far as the writer has been able to learn this is the only deposit which has been found containing euhedral crystals of kaolinite. (Fig. 1.)

Previous Investigations

According to K. Spangenberg[2] kaolinite begins to dehydrate at 430°C but only loses one-quarter of its water of hydration at this temperature. The mineral becomes almost completely dehydrated when heated at 650°C for a short time. After heating, the refractive index decreases from 1.568 to about 1.464. During this change the mineral becomes uniaxial negative but retains its birefringence without change. Such dehydrated kaolinite has been called metanacrite by Rinne.[3] According to Rinne the alumina may be dissolved out of the metanacrite with HCl and the remaining silica is negative uniaxial with unchanged birefringence and a refractive index of 1.440. This is similar to the silica skeletons left after treating mica with sulphuric acid.

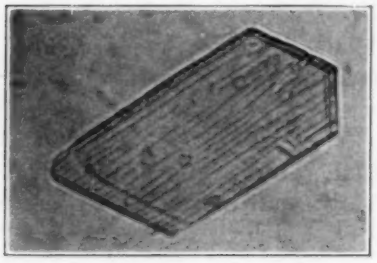

FIG. 1.—Natural crystal of kaolinite; magnification about 300 diameters.

Klein[4] working with samples of North Carolina and English kaolins reported that at the dehydration temperature the kaolinite became

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February 1928. (White Wares Division.)

[2] K. Spangenberg, *Cent. Min.*, A, p. 417 (1926).

[3] F. Rinne, *Zeit. Kryst.*, LXI, p. 119, quoted in "The Optic and Microscopic Characters of Artificial Minerals" by A. N. Winchell.

[4] A. A. Klein, "The Constitution and Microstructure of Porcelain," *Trans. Amer. Ceram. Soc.*, **8**, 377 (1916).

isotropic but developed crystals at a temperature above 1400°C, these often giving a rather cross-hatched appearance to the grains.

Method of Experiment

A platinum-wound tube furnace was used in this work. The kaolinite crystals were placed in small platinum boxes which were grouped around a calibrated noble metal thermocouple, the temperature being measured by a type K Leeds and Northrup potentiometer. The temperature was raised according to the curve shown in Fig. 2 and draw trials were made at frequent intervals.

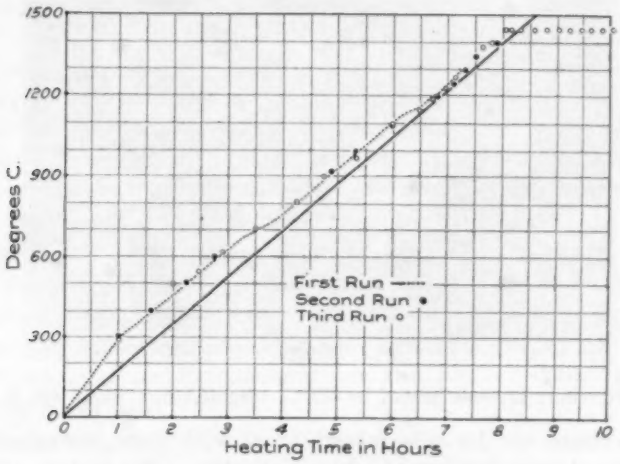

FIG. 2.—Heat treatment of kaolinite crystals.

Results and Conclusions

Up to and including temperatures of 600°C there was no noticeable change in the optical properties of the kaolinite except a slight cloudy appearance at the edges. At 625°C (see Fig. 3), the crystals became practically uniaxial negative and retained this form until 1400°C was reached. The birefringence was greater than that of the natural kaolinite crystals and the crystals did not appear to be homogeneous and consequently it was not possible to determine their refractive indices accurately. These were for the outer edges of the crystals, at least below 1.54. The crystals were cloudy and appeared to be broken into very thin plates and under strong illumination interference fringes were noticeable. There was no change in their optical properties at 900°C which might have been expected since Mellor and others have reported an exothermic reaction to take place at that temperature. At 1400°C they began to lose their cloudy appearance. When these crystals were held at 1450°C for two hours the cloudy appearance vanished and they gave no interference figures. A crystal development

took place, however, which consisted of a cross-hatched appearance with the small crystals arranged in rhombs. (See Fig. 4.) The crystals were probably mullite but they were so minute that their optical

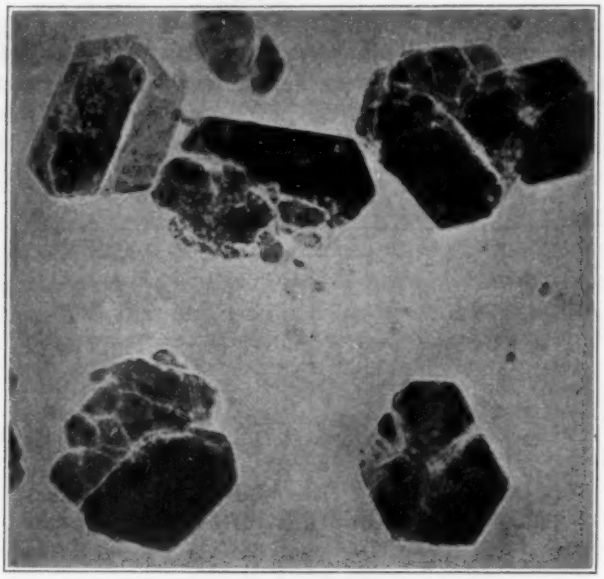

FIG. 3.—Kaolinite crystals heated to 625°C, magnification about 300 diameters.

properties could not be determined, even with a magnification of 900 diameters and using a $^1/_{16}$-inch objective. Throughout the entire range of heating, the crystals did not lose their external form.

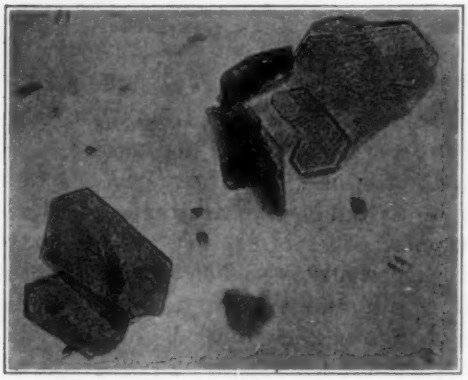

FIG. 4.—Kaolinite crystals heated at 1450°C for two hours, magnification about 300 diameters.

Owing to the very limited amount of material available it was impossible to carry this investigation further.

From the results of this investigation, the changes in kaolinite, when heated, may be grouped into three classes: (1) the natural kaolinite, (2) the uniaxial form produced at 625°C (at the above rate of heating); the metanacrite of Rinne, (3) the change of the metanacrite into what is probably mullite and glass at 1450°C.

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THE LABOR AND AIR-POWER COST OF SAND-BLASTING[1]

By Edward H. Stehman

ABSTRACT

Efficiency data are given from experience on adjustment of air and sand quantities, size and shape of nozzle, and distance of nozzle from the work. Production data are given on blasting of large ware and barrel cleaning of small ware. The data are shown in curves.

1. Introduction

In the process of enameling, one of the essentials is the thorough preparation and cleaning of the metal surface. This must be done on large production scale at a low cost. For this operation sand-blasting has been generally adopted. It removes all foreign matter and graphitic carbon from the surface, and leaves the castings clean and dry, suitable for enameling.

Labor, wherever possible, is being supplanted by modern machinery. The present day equipment has greatly improved the working conditions. The efficiently ventilated rooms and barrels automatically dispose of the dust. The various means for conveying the abrasive and for the removal of all foreign material make the circulation of the sand practically automatic.

Two important factors, however, are more or less subject to the judgment of the operator: adjustment of the mixture of air and sand, and the distance of the nozzle from the work. Both of these have a marked influence on air-consumption and blasting-time, and should be closely supervised.

The principal items of cost in sand-blasting are labor, overhead, air-power, and the abrasive. It has been found by numerous tests that great economies can be effected by adopting air pressure and size of nozzles better suited to the work in hand.

As a general rule, the existing air pressure is used when the sand-blast equipment is first installed and small nozzles employed to relieve the load on the air compressor. This does not necessarily show the best economy.

Theoretically there is required a definite amount of energy to do a given amount of work, but practically we must consider the sand-blast abrasive as a tool, consuming compressed air as its power. Since air-consuming devices may vary greatly in efficiency, the problem then resolves itself into determining the lowest pressure and proper size nozzle that will clean the fastest and consume the least amount of air power.

No fixed rule can be adopted, since the kind of metal, the foundry practice, and the size and shape of the castings all have their influence on

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Enamel Division.) Received December 28, 1927.

the results. The size nozzle best adapted for blasting bath tubs may not be practical for small stove castings. Likewise the pressure suitable for first blast on castings may be too low for de-enameling.

2. Air and Sand Adjustment

Most of the sand-blast machines are provided with a convenient means for adjusting the proportion between sand and air. The operator usually first turns on the air and sets the sand flow according to his judgment. In this hit-or-miss adjustment rests the difference between an efficient and a wasteful tool in the factors of air power and labor hours.

A practical indication of the proper adjustment is found when a good blue flame is seen at the point where the sand strikes any ferrous work, which is always the case when the mixture is rich.

It must be borne in mind that it is the abrasive that actually does the cleaning. The air is merely a vehicle carrying the abrasive from the sand-blast machine to the work at the proper velocity; therefore, it is advisable to have a rich mixture. On the other hand too rich a mixture causes flooding which reduces the velocity of the abrasive to a point where little or no work can be accomplished. In a lean mixture the velocity will be found to be satisfactory, but there are not enough abrasive particles striking in proportion to the amount of air which is being consumed.

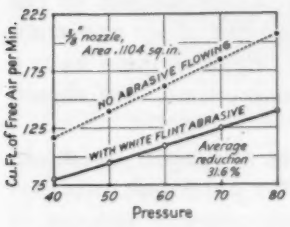

FIG. 1.—Air-consumption with and without abrasive flowing.

If, when instructing an operator on the adjustment of his mixture, an indicating flow meter were used, it would be found that by taking readings of the air flow without the abrasive and again with the abrasive flowing, there would be a reduction of air of approximately 30% when using a uniform small-grain flint abrasive. (See Fig. 1.) This is especially true when using the customary $^3/_8$-inch nozzle with the equipment in good working order. For smaller nozzles, the reduction is usually less, and for larger nozzles it is greater.

This partly explains the reason why a $^9/_{16}$-inch nozzle having an area of 0.2485 square inch does not consume twice as much air with the abrasive flowing as a $^3/_8$-inch nozzle with an area of 0.1104 square inch, even though its area is more than twice as great.

3. Distance of Nozzle from Work

The second factor in which the operator frequently goes wrong is the distance that the nozzle is held from the work.

On green castings it is advisable to hold the nozzle 10 to 12 inches from the parts being blasted. At this distance the greatest surface is covered without impairing the effect of the air pressure.

On de-enameling, this distance can be reduced.

4. Effect of Pressure on Blasting Time

Why is high pressure so frequently used when a lower pressure is more efficient and economical? Possibly the chief reason is that high pressures, varying from 80 to 100 pounds, are necessary for various foundry equipment such as squeezers, vibrators, and air hoists, and are consequently used for the sand-blast.

A separate lower-pressure compressor and piping system would be ideal for the sand-blast department; in fact, quite a few plants maintain such a separate system. Where this is not done, pressure regulators can easily be installed to reduce and maintain a constant pressure for each individual sand-blast machine.

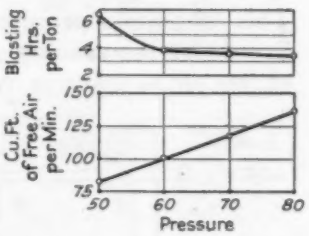

FIG. 2.—Air-consumption and time-characteristic curve; 3/8-inch nozzle, de-enameling stove doors.

In Fig. 2 is shown a typical air consumption and time characteristic curve. For a given size nozzle-opening, the volume of the air varies directly with the pressure. This, however, is not the case with time. The time-curve, while typical for many classes of work, was in this case taken from a test on de-enameling stove doors. The time is practically constant, from 80 down to 60 pounds, at which point it increases rapidly. Sixty pounds is therefore the lowest effective operating pressure on account of time. It is also the most economical from the standpoint of air consumption.

In the case cited, the fact that the time increased rapidly below 60 pounds would indicate that this is the point in the curve where the force of impact of the abrasive just equals the force of cohesion holding the enamel to the body. The kinetic energy in the abrasive above this point is practically all lost in peening the surface of the metal and destroying the abrasive itself, with very little saving in time. Any slight saving in time above this point is due to an increase in the quantity of abrasive flowing caused by the increased velocity.

The problem of production is mainly a matter of the size of nozzle opening, bearing in mind the available air supply and the size and character of castings to be blasted. In making a study of pressure and nozzle size very accurate comparisons can be made as first of all the castings must be perfectly clean or they will be rejected by the enameling department.

5. Metering Equipment Used in Tests

An indicating flow meter of the differential type was employed for measuring the air-consumption. It was connected across a 2- by 1-inch well-rounded orifice as shown in Fig. 3 and calibrated according to the following formula

$$V = 66.08 \sqrt{\frac{H}{S}} \sqrt{\frac{14.7+P}{14.7}}$$

where V = velocity in feet per second
66.08 = a constant
H = head in inches as read on the meter
S = specific gravity (referred to air as unity)
P = the gage pressure
14.7 = the absolute pressure

This calibration permitted taking the air measurement in the supply line under the existing pressure and indicating the air-flow in terms of free air as taken in by the compressor.

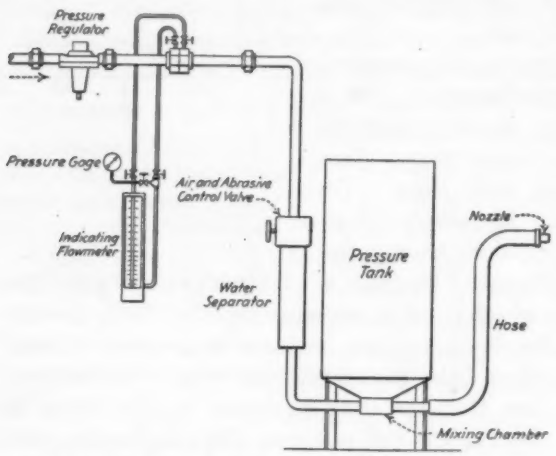

FIG. 3.—Typical flow meter installation for metering air-consumption and regulating air-pressure.

In addition to measuring the air-consumption, the meter served as an indication of the fluctuations in the sand and air-mixing chamber. When the machine feeds uniformly the indication on the meter is constant. Fluctuations on the meter always indicate that the sand is feeding irregularly. This may be caused by moisture in the abrasive, or foreign particles such as small pieces of iron obstructing the passage. Fluctuation in the sand-feed slows down production and should be corrected promptly.

The air pressure was regulated by means of a pressure regulator installed in the line ahead of the air metering equipment. The pressure was set to predetermined points as indicated on the pressure gage connected to the air-meter.

In all the tests the pressure referred to is that at the sand-blast machine and not the pressure at the nozzle. Nozzle pressure is.

of course, lower because of frictional resistance through the system. This will account for different rates of air-flow for the same size nozzle opening on parallel tests in different plants. The design of the mixing chamber, the number of fittings, and the wear or mechanical condition of the equipment all have their influence on the air consumption.

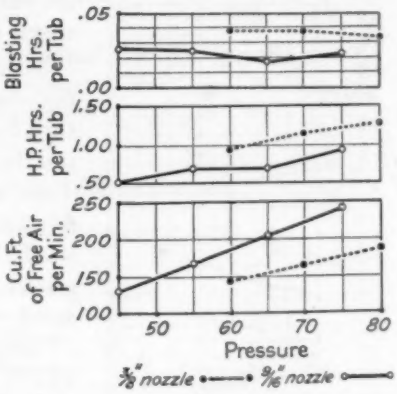

FIG. 4.—Air-consumption, air-power, and blasting-time curves; blasting 5-foot tubs using $^3/_8$- and $^9/_{16}$-inch nozzles.

6. A Study of Pressures and Nozzle Sizes

Test 1. Bath Tubs A series of tests was conducted on bath tubs to determine the most efficient pressure and nozzle-size for first blast. Five-foot tubs were blasted, as received from the foundry, removing approximately 20 pounds of burnt molding sand per tub. Six tubs were placed in the sand-blast room for each set of tests and the actual blasting time as well as the air-consumption recorded. The data collected are given in Table I and shown in the curve, Fig. 4.

TABLE I

AIR-POWER AND BLASTING-TIME FOR SIX 5-FOOT TUBS, 210 POUNDS EACH. (First Blasting Removing Foundry Sand)

Pressure (pounds)	Size nozzle (inch)	Free air cu. ft./ min. (abrasive flowing)	H.P. actual at 70% compressor efficiency	Time in minutes and seconds	Air-power H.P. hrs./tub	Labor blasting hrs./tub
80	$^3/_8$	189	37.0	12′ 0″	1.232	0.0333
70	$^3/_8$	165	30.2	13′ 50″	1.161	0.0384
60	$^3/_8$	142	23.9	14′ 0″	0.931	0.0389
75	$^9/_{16}$	240	45.7	7′ 36″	0.961	0.0211
65	$^9/_{16}$	205	36.0	6′ 40″	0.666	0.0185
55	$^9/_{16}$	170	27.5	8′ 55″	0.679	0.0247
45	$^9/_{16}$	133	19.1	9′ 45″	0.516	0.0271

The practice had been to blast at 80 pounds through $^3/_8$-inch nozzles, but tests with $^3/_8$-inch and $^9/_{16}$-inch nozzles at various pressures demonstrated that 65 pounds with $^9/_{16}$-inch nozzles gave the largest production per hour. It was very desirable, however, to reduce also the rate of air consumption. Minimum air was used with the $^9/_{16}$-inch nozzle at 55 pounds pressure. This last combination of nozzle size and pressure as compared with $^3/_8$-inch nozzles at 80 pounds pressure reduced the rate of air-flow 10%, the blasting-time 26%, and the air-power 45%.

Test 2. Bowls In a jobbing enameling plant sand-blasting of old rusted bowls delayed production and partly tied up the furnaces. In this case the problem was to speed up this class of work.

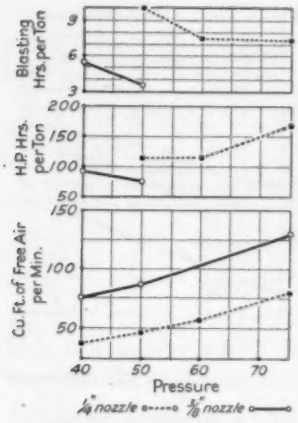

FIG. 5.—Air-consumption, air-power, and blasting-time curves; blasting bowls before enameling, using 1/4- and 3/8-inch nozzles.

Tests were made at 75, 60, and 50 pounds pressure on two bowls weighing 94 pounds each for each set of readings, using the 1/4-inch nozzle which had been regularly employed. Tests were also made with a 3/8-inch nozzle at 50 and 40 pounds. The results are given in Table II and in Fig. 5. The 3/8-inch nozzle at 50 pounds consumed about the same volume of air as the 1/4-inch nozzle at 75 pounds which resulted in a reduction of 47.5% in blasting-time and 53.5% in air-power. This not only increased production but also reduced the sand-blasting costs considerably. When this is figured in terms of dollars and cents we have the following savings:

Saving in blasting time, 3.41 hrs. per ton of metal cleaned, at $1.00 per hr. plus 100% for overhead or	$6.82
Saving in air power, 91.5 H.P. hrs. per ton of metal cleaned at 2 cents per H.P. hr. or	1.83
Total saving per ton	$8.65

TABLE II

AIR-POWER AND BLASTING-TIME FOR TWO C. I. BOWLS (94 pounds each; removing scale and rust before enameling)

Pressure (pounds)	Size nozzle (inch)	Free air cu. ft./min. (abrasive flowing)	H.P. actual at 70% compressor efficiency	Time in minutes and seconds	Air-power H.P. hrs./ton	Labor blasting hrs./ton
75	1/4	80.0	23.8	28′ 30″	171	7.18
60	1/4	58.2	15.5	30′ 0″	117	7.54
50	1/4	48.2	11.4	40′ 0″	114	10.05
50	3/8	88.5	21.1	15′ 0″	79.5	3.77
40	3/8	74.2	15.3	21′ 40″	93.5	5.45

Test 3. Miscellaneous Stove Castings Small castings are most economically cleaned in sand-blast barrels. One man and a helper can easily take care of three machines. The three barrels will, however, have many nozzles, consuming a large volume of air. A study of the pressure and air-flow is therefore important.

In a stove plant tests were conducted on a pressure type barrel with two 3/8-inch nozzles, cleaning miscellaneous stove parts. The results of these tests are shown in Table III and Fig. 6.

By reducing the pressure from 80 to 50 pounds the actual air consumption was reduced 105 cubic feet per minute or 37%. This saving of 105 cubic feet is sufficient to operate a hose-machine with a $^3/_8$-inch nozzle at 60 pounds pressure.

Reducing the pressure in this case increased the blasting time 14%. Even though the blasting time was increased, the cost of cleaning was lowered on account of the reduction in the air power. This figures in dollars and cents as follows:

Saving in air power, 23.3 H.P. hrs. per ton of castings cleaned at 2 cents per H.P. hr. or	46.6 cents
Increase in blasting time, .13 hrs. per ton of castings cleaned at $1.00 per hr. plus 100% for overhead or	26.0 cents
Net saving per ton	20.6 cents

An important consideration in this plant was that their air-compressor was overtaxed, and a saving of 105 cubic feet of free air per minute relieved this situation.

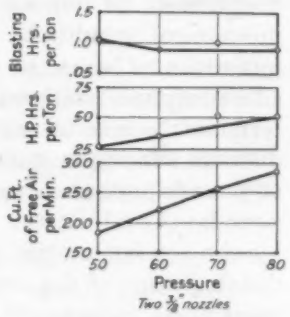

FIG. 6.—Air-consumption, air-power, and blasting-time curves; cleaning miscellaneous stove castings.

7. Distribution of Costs

Too little is known about the actual cost of sand-blasting. Many executives have the idea that their abrasive is a major cost factor, whereas the reverse is true. While it is difficult to set down general figures that will apply to any specific plant or class of work, the tabulation of figures from a large number of tests in enameling and other plants leads to the conclusion that the principal factors in sand-blasting costs average as follows, (1) labor and overhead, 65%; (2) air-power, 20%; and (3) abrasive, 15%.

TABLE III

AIR-POWER AND BLASTING-TIME, CLEANING MISCELLANEOUS STOVE CASTINGS IN PRESSURE TYPE BARREL (Using two $^3/_8$-inch nozzles; 565 pounds per load)

Pressure (pounds)	Size nozzle (inch)	Free air cu. ft./min. abrasive flowing	H.P. actual at 70% compressor efficiency	Time in minutes and seconds	Air-power H.P. hrs./ton	Labor-blasting hrs. per ton
80	$2^3/_8$	285	55.8	15′ 30″	51.1	0.915
70	$2^3/_8$	260	47.3	18′ 20″	51.3	1.085
60	$2^3/_8$	226	37.5	15′ 34″	34.5	0.920
50	$2^3/_8$	180	26.6	17′ 41″	27.8	1.045

In this tabulation there were some plants in which the character of work and conditions of operation brought the abrasive cost up as high as 30%; while there were others in which it was as low as 4%.

But assuming that 15% is a fair average abrasive cost and that the character and efficiency of the abrasives have a large influence on the

remaining 85% of the sand-blasting cost, it is evident that the selection of abrasives should be predicated on the work to be done.

8. Conclusions

The three tests described are typical of many tests conducted under actual operating conditions in various plants throughout the country, not only in enameling plants but also in malleable, brass, and steel foundries, all pointing to similar conclusions.

The tests were conducted with a single thought in mind, namely, to determine the proper pressure and size of nozzle-opening which will permit the abrasive to clean the fastest, leave a satisfactory surface, and consume the least amount of air-power.

Substantial savings can be insured by supervising the sand-blast department as follows: (1) keep the sand-blast equipment in good mechanical condition; (2) make actual time-studies on identical quantities of work to determine the lowest pressure which can be effectively used without materially affecting the blasting-time; (3) determine the size of nozzle-opening that will give the maximum production, bearing in mind the available air supply; a $^3/_8$-inch nozzle at 60 pounds pressure is usually more efficient than a $^1/_4$-inch nozzle at 90 pounds; (4) adjust the exhaust system to carry away all dust caused by the foreign matter removed by the sand-blast abrasive, and the disintegration of the abrasive itself; and (5) maintain the pressure constant at the determined point of maximum efficiency.

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PHYSICAL AND CHEMICAL PROPERTIES OF OILS AND PROBLEMS OF THEIR REMOVAL[1]

By F. H. Guernsey

ABSTRACT

Tool lubrication in sheet metal working is principally a matter of rapid development of a stable but deformable film. Viscosity is of lesser importance. Structure of the film is more important than thickness. Removal problems involve neutralization, wetting, emulsification, and direct counter colloidal pull to disrupt and disperse the film completely. Free rinsing of detergents and suspensions is necessary.

Introduction

The ceramic industry consumes large quantities of various lubricants in the form of oils, fats, or "compositions" for the purpose of protecting metal and tools by lubrication and cooling in the various stamping, drawing, and spinning operations.

The oils, fats, and greases afford an almost unlimited number of choices and combinations. Altogether too often the composition of lubricants is determined more by fluctuations in the oil market than by their desirability for the purpose intended especially when the manufacturer is facing a rising market and endeavors to escape losses by questionable substitution.

The function of a lubricant is to reduce wear and tear upon metal and tools, producing a smooth surface without "bite" and lengthening the serviceable life of the tools. Coöperating with the metal and tool is a rugged and satisfactorily permanent film between the metal and tool. The adhesion or film-forming capacity of the lubricating material upon the metals is therefore of prime and basic importance.

Film Development and Properties

The development of film (adhesion) is progressive and proceeds rapidly for a number of hours. Adhesion varies with different metals and often with only slight differences in the alloy composition of a given metal such as steel. Adhesion, being a surface phenomenon, would be expected to be subject to variation due to the presence of surface impurities, and this is exactly the case, as in the presence of oxides, rust, etc.

The difference between various oils from the standpoint of lubrication has led to intense study of the differences between various lubricants. For tool lubrication, there has been a preference for animal and vegetable oils which seem to have a film-forming capacity superior

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to that of ordinary mineral oils. Experience indicates that the straight mineral oils are slower to build up a film, though the ultimate film may be considerably thicker than the film produced by a vegetable or animal oil.

The thickness of the film, however, is not an index of the lubrication value since the permanence of the film, a function of its structure, is of greater importance than thickness. Thus, a thin, tightly-adhesive film has a greater value than a thick, loosely-bound film. The film must also conform satisfactorily to the shape of the tool. There is evidence that the mineral oils are more compressible than the fatty oils.

Investigators noting a difference in film-forming capacity between straight mineral oils are striving to identify those active groups or derivatives which influence the film-forming capacity of the oils and, to construct compositions of definite and tangible lubricative value, by elimination of those which impair the adhesiveness, and by addition of reinforcement.

It has been well-established that the adhesion is primarily due to selective adsorption by the metal surface. The tighter this adsorption the more durable and permanent the lubricative film.

The tendency of some lubricants to travel ahead of the heat as it progresses through metal is well known and is a primary cause of unsatisfactory lubrication where the friction load is considerable. A fixed film will not travel, or at the most will travel slowly. A good lubricating film is always present in the vicinity of the tool.

Organic acids, some unsaturated hydrocarbon derivatives, and some combined sulphur derivatives have been recognized as examples of film-forming constituents and as a natural deduction, the addition of small quantities of fatty acids to some straight mineral oils should increase their film-forming capacities. At least the claim is made that free fatty acid is the active constituent of the fatty oils, and additions of free fatty acids to mineral oils to increase their adhesiveness is successfully practiced.

Process of Tool Lubrication

The process of lubrication may then be summed up as, (1) application of oil to metal surface; (2) with a lapse of time certain constituents in the oil work their way to the metal surface; (3) these constituents are adsorbed on the metal surface in the form of a loose chemical combination, thus constructing a foundation film, tightly adhering to the metal surface; and (4) with further lapse of time upper layers of oil build up the thickness of the film.

Since the upper layers may be removed much more easily than the foundation film (which probably constitutes 5 to 25% of the total thick-

ness) it is demonstrated that adhesion is much more important in lubrication than cohesion.

From the standpoint of sheet metal lubrication for drawing, stamping, etc., the chief physical properties demanded of a lubricant are: (1) sufficient viscosity to prevent any considerable loss by dripping away from the metal and a retention of this viscosity at working temperatures; and (2) a rapid and substantial film development.

Chemical Properties

Mineral Oils The mineral oils are known as hydrocarbons and these cannot be saponified to form soap. The two main classes of mineral oils are those from a paraffin base and those from an asphaltic base. The former type seems to be favored as a lubricant, though such preference is probably diminishing. With the exception of free fatty acids, the active film-forming groups do not exhibit pronounced chemical properties.

Many semisolid mineral greases contain metallic soaps, such as calcium, magnesium, aluminum soaps, etc. These ingredients, in addition to serving to increase the viscosity of the oils to which they are added, will contain considerable ash as is revealed in scaling. These metallic soaps are very water-repellent and consume acids and alkalis chemically.

Fatty Oils The fatty oils are mixtures of materials composed of hydrogen, oxygen, and carbon. They are essentially glycerides of the fatty acids. The predominating acid in the oils (or liquid fats) is the unsaturated oleic acid, while the proportion of the saturated acids, stearic and palmitic, increases as the solidity of the oil or fat increases. They (the oils) are saponifiable by alkalis to form soaps and glycerin.

Practically all commercial oils contain some free fatty acid which is the active principle in adhesive film forming. In fact, prolonged action of the fatty acids upon metal will occasionally attack or combine sufficiently to pit the metal.

Certain fatty oils will absorb oxygen from the atmosphere and tend to dry. Three classifications are designated on this basis as "drying," "semidrying," and "nondrying" oils, though members of the latter class will absorb small amounts of oxygen. This so-called drying process results in the formation of a varnish-like film which in time will become very hard. Linseed oil is an outstanding example of a drying oil, while lard oil is a good example of a nondrying oil.

Rancidity and fermentation, resulting in an increase in the fatty acid content, is common among fatty oils, particularly when refining methods have not been thorough and an assisting moisture content is present.

Sulphonated Oils Sulphonated oils or "soluble oils" are the result of reaction between strong sulphuric acid and an oil, the reaction being controlled at moderate temperatures. Many of the oils may be sulphonated but the most common is sulphonated castor oil, or an oil containing a large proportion of ricinoleosulphuric acid. These oils are mostly used in mixtures with other lubricants to produce a lubricant which readily mixes with water, the latter being of value as a cooling agent in tool lubrication. The greater the degree of sulphonation, the more soluble the product will be in water.

Mixtures or "Compositions" These materials are blends of certain oils, fats, waxes, etc. to produce a lubricant having composite properties. In some of the heavier compositions one often finds mineral lubricants, such as talc, amorphous chalk, zinc oxide, lithopone, lead compounds, etc. These materials contribute a permanence factor to the lubricant but often complicate matters by a slow chemical reaction with the oil constituents. It is extremely important that these compositions be so prepared as to retain a homogeneous condition. Separation of any of the constituents from the body of the composition is likely to upset the entire balance of properties.

Problems of Removal

Good lubrication is primarily a matter of adhesion, and as adhesion usually increases with time up to a certain point, the firmness of the adhesion and age of the film have considerable bearing on the problems of removal.

Removal by scaling is not altogether satisfactory, because of the heavy pickling required to remove rust and ash from the metal surface. Heavy pickling opens the way for troubles from hydrogen absorption by the metal, and later blisters, an imperfect adhesion of ground coats, and even glazes.

Chemical cleaning by the wet process is satisfactory, provided the conditions involved are understood.

Alkaline detergents, with or without soaps, are generally used in the first operation at a temperature varying from 140° to 200°F.

Mechanism of Cleaning

The efficient cleaning solution first "wets" the oily surface. If the oil in question is practically a pure mineral oil, the cleaning solution must have a low interfacial surface tension to accomplish effective wetting.

Agitation of the cleaning solution is important at this point because when once wetted, the oil will begin to adhere to colloidal elements in the cleaning solution and break away.

If the oil is of the fatty glyceride type, or contains considerable such oil, a direct reaction between the oil and the alkaline medium in the solution will produce sufficient soap to increase the wetting power and speed up a loosening of the oil.

The efficient cleaning solution will be capable of emulsifying the separated oil by enveloping the oil droplets in a tough resistant film which prevents their coalescence into larger drops, or re-attraction toward the metal surface.

The cleansing operation has thus far proceeded only through the upper layers of the lubricative film. The basic adhesive film which is in direct semichemical contact with the metal resists wetting to a greater extent than the upper layers, due probably to the presence of an iron soap or iron ester with some active adhesive organic substance in the lubricating oil.

The adhering adsorbed film must be disrupted and separated from the metal surface by counter action. Effective cleaning solutions will possess colloidal properties which will exert a colloidal pull or force of greater magnitude than the adhesive force between the metal and the film, and in the opposite direction. A chemical action, replacing the iron in the film complex with a soluble alkali base, operates in conjunction with the physical colloidal action with the result that the film constituents are separated and taken up into suspension by the cleaning solution. The cleaning solution displaces the film and wets the metal surface itself.

Lubricants containing metallic soaps, pigments, or drying oils require additional chemical action to consume their resistant elements.

As some time is required to build up a tight lubricating film, time is likewise required to disrupt and disperse such films. The more complicated the structure of the film, the more exacting the requirements of the cleaning solution.

The destruction of the film should be so complete that there should be little danger of re-adhesion during the rinsing operation.

Free rinsing of detergents and suspensions and clean rinse tanks are essential to prevent oily constituents and soaps from being carried into the pickle tank to hinder the action of the pickle. Soaps are destroyed by pickle, setting free their combined grease which in turn contaminates the neutralizing tank and is probably retained as a contamination on the ware as it passes on to the enameling operations.

Summary

Lubricating oils should be selected primarily from the standpoint of serviceability and secondarily from the standpoint of cleanability.

Lubricants of composite desirable properties combining serviceability

and cleanability with versatility providing protection against variations in the metal stock being worked may be created by intelligent study of the set of conditions involved.

Aside from variations common to all products of nature, the composition should be religiously maintained as unanticipated changes may result in troubles extremely difficult to trace.

Cleaning solutions should be capable of dispersing the closely bound film as well as the upper and more loosely held portion.

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USE OF MANGANESE IN THE MANUFACTURE OF FACE BRICK[1]

By Gilbert E. Seil and H. A. Heiligman

ABSTRACT

The effects on color of variation in size of manganese particles, composition of the manganese, and of the character of gaseous conditions of firing are discussed.

Introduction

Manganese dioxide is commonly used in the manufacture of clay brick as an addition, either to change the background color, or to produce a speckled brick or both. Although the same basic material is used to obtain both of these effects, the particle size is the determining factor. Very small particles influence the background color, and the variation in particle size determines the size of the spot. The particles which pass through a 0.0017-inch opening (325-mesh) are too small to produce spots and therefore affect only the background, whereas particles as small as 0.0029 inches (200-mesh) produce a very decided spot without affecting the background color.

There are two stages in the manufacture of a clay brick containing additions. The first stage is the preparation of the brick for firing, and includes the selection of the particle-size ratio, the amount of the addition, the method of making the addition, and the method of distributing the addition. The second stage in the manufacture is the actual firing of the brick and under this subject enough cannot be said.

Kiln Firing Is Variable There are so many variables in kiln conditions that it is difficult to fire two kilns in exactly the same way and get exactly the same results, although they may be constructed alike. In a coal-fired kiln having eight fire boxes, if five boxes are oxidizing and three reducing, the condition of the kiln is considered to be oxidizing. Yet in this kiln there are zones which are strongly reducing, zones which are strongly oxidizing, and zones of every degree between strongly oxidizing and strongly reducing.

Each variation in the kiln atmosphere has a decided effect on the finished brick. Inasmuch as the usual periodic kiln is not fired in such fashion that the atmosphere and the temperature curve are uniform, it is a rarity to obtain a uniform product from such a kiln. The temperature curve is usually saw tooth, that is, there is a rise and fall in temperature which is by no means regular and which is by no means distributed equally throughout the kiln.

Temperature measurements and analyses of kiln gases have little value unless the temperature measurements are taken at such a point that the *average* kiln temperatures are recorded, and the samples

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for analysis are representative of the gases in the kiln. The temperature measurements usually indicate the kiln temperature and do not as a rule indicate the temperature of the ware. This is particularly true of the tunnel type of kiln. Although the kilns are normally set so that the draft should be uniform, there is, nevertheless, a tremendous variation in draft which causes local differences in temperature and atmosphere and finally variation in the ware.

Experimental Work

In order to study the effects of: (1) oxidizing and reducing atmospheric conditions, (2) varying percentages of additions to the clay, (3) particle size of the added colorant, and (4) definite ratios of particle sizes, the following program was carried out with meticulous care.

The Clays Six different clays were used: (1) Armstrong County, Pa., (2) Beaver County, Pa., (3) Clearfield County, Pa., (4) Perry County, Ohio, (5) Tuscarawas County, Ohio, and (6) Starr County, Texas.

The pyrometric cone equivalents and the chemical analyses of these clays are shown in Table I.

TABLE I

FIRING TEMPERATURE AND CHEMICAL ANALYSES OF CLAYS USED

	Armstrong	Beaver	Clearfield	Perry	Tuscarawas	Starr
Firing temp.	2100°F	2100°F	2250°F	2050°F	2100°F	1800°F
Silica	56.55	63.64	62.42	62.54	62.73	48.92
Alumina	29.17	23.53	26.96	21.40	23.53	5.54
Iron oxide	2.26	2.12	3.38	3.24	1.90	3.38
Lime	.03	None	.07	.03	None	11.12
Magnesia	1.12	1.08	1.21	.63	.90	1.71
Titanium oxide	2.87	2.33	4.43	3.83	3.67	5.48
Alkalis	1.14	.58	1.76	1.66	3.76	10.13
Loss on ignition	6.86	6.72		6.67	7.18	13.72
Gain on ignition			.23			
P.C.E.	Cone 3	Cone 3	Cone 7	Cone 2	Cone 3	Cone 06

Manganese Ores Used Before deciding on which of the available manganese ores to use for these experiments, preliminary tests were made on four samples. Two of these were Virginian manganese ores, which will be designated as Virginian manganese ore I, and Virginian manganese ore II, and other samples were Porto Rican manganese ore and Brazilian manganese ore.

The fusion points of these ores are as follows:

TABLE II

FUSION POINTS OF MANGANESE ORES

	Oxidizing	Reducing
Virginian ore I	2600°F	2500°F
Virginian ore II	2540°	2320°
Porto Rican ore	2500°	2480°
Brazilian ore	2300°	2280°

Chemical analysis of these ores are given in Table III.

TABLE III
CHEMICAL ANALYSES OF THE MANGANESE ORES

	MnO_2	Fe	Insoluble Matter
Virginian Ore I	63.85%	0.85%	30.50%
Virginian Ore II	60.25%	4.74%	22.64%
Porto Rican Ore	65.64%	.85%	8.45%
Brazilian Ore	71.40%	3.02%	12.50%

Colorant The original program called for a series of bricks made from the following mixes:

(1)	Clay						(17)	Clay	2%	air-floated	manganese	ore*	
(2)	"	1%	air-floated	Imperial	Gray		(18)	"	3%	"	"	"	"
(3)	"	2%	"	"	"	"	(19)	"	1%	Grind I	"	"	
(4)	"	3%	"	"	"	"	(20)	"	1%	" II	"	"	
(5)	"	4%	"	"	"	"	(21)	"	1%	" III	"	"	
(6)	"	5%	"	"	"	"	(22)	"	1%	" IV	"	"	
(7)	"	1%	20–40-mesh		"	"	(23)	"	1%	" V	"	"	
(8)	"	1%	40–60-	"	"	"	(24)	"	1%	" VI	"	"	
(9)	"	1%	60–80-	"	"	"	(25)	"	1%	20–40-mesh	"	" *	
(10)	"	1%	80–100-	"	"	"	(26)	"	1%	40–60-	"	"	"
(11)	"	1%	100–140-	"	"	"	(27)	"	1%	60–80-	"	"	"
(12)	"	1%	140–200-	"	"	"	(28)	"	1%	80–100-	"	"	"
(13)	"	1%	thru 200-	"	"	"	(29)	"	1%	100–140-	"	"	"
(14)	"	½%	air-floated	manganese	ore		(30)	"	1%	140–200-	"	"	"
(15)	"	1%	"	"	"	"	(31)	"	1%	thru 200-	"	"	"
(16)	"	1½%	"	"	"	"							

* Brazilian.

After making two sets of these bricks it became apparent that air-floated manganese in excess of .500% and air-floated Imperial Gray in excess of 1.5% produced colors which were too deep for practical purposes. For this reason the program was extended and bricks were made from the following mixes:

(32)	Clay	.5%	air-floated	Imperial	Gray		(35)	Clay	.125%	air-floated	manganese	ore	
(33)	"	1.0%	"	"	"	"	(36)	"	.250%	"	"	"	"
(34)	"	1.5%	"	"	"	"	(37)	"	.375%	"	"	"	"

The screen analyses of these additions are given in the following table:

TABLE IV
SCREEN ANALYSES OF THE ADDITIONS

	Air Floated Material	
	Imperial Gray	Manganese Ore
On 200-mesh	1.02%	0.5%
Through 200- on 325-mesh	11.86%	12.5%
Through 325-mesh	87.12%	87.0%

Grind I		Grind II	
Remained on 16-mesh	0.0%	Remained on 20-mesh	.5%
Through 16- on 24-mesh	2.5%	Through 20- on 30-mesh	2.5%
" 24- " 40- "	80.0%	" 30- " 40- "	27.5%
" 40- " 60- "	15.0%	" 40- " 60- "	57.5%
" 60-mesh on pan	2.5%	" 60-mesh on pan	12.0%

	Grind III	Grind IV	Grind V	Grind VI
Remained on 40-mesh	9.1%	0.1%	.1%	0.0%
Through 40- on 60-mesh	16.0	11.7	2.5	0.0
" 60- " 80- "	10.1	11.1	8.2	.4
" 80- " 100- "	8.6	7.7	7.3	.7
" 100- " 140- "	7.7	8.4	9.5	3.9
" 140- " 200- "	7.2	8.4	9.1	5.6
" 200- " 325- "	5.7	8.5	12.8	11.5
" 325-mesh	35.6	44.1	50.5	77.9

Making Wet screen tests were made on grinds III, IV, V, VI, and on the air-floated materials. The clay was ground in a 3-foot overhead-drive pan. When additions were made, the clay and the colorant were thoroughly mixed in a Day mixer, until the distribution was uniform. The clay was then tempered for 24 hours and made into briquets 2 by 1 by $^3/_8$ inches in small hand molds. These briquets were fired after being dried for four or five hours at 200°F.

Firing The firing was done in a muffle kiln 10 by 18 by 9 inches. This muffle was heated by one burner and the products of combustion did not come into contact with the ware. The open end of the muffle was sealed by a sliding door, which could be opened for the removal of test brick, or for making observations. In the closed end of the muffle a heavy Carborundum tube was placed to hold the platinum thermocouple, by which temperatures were measured. Into this end of the muffle a small porcelain tube was sealed, through which either air or illuminating gas could be admitted. When an oxidizing atmosphere was desired, an air line was connected to this tube, and a regulated stream of air flowed into the muffle. When a reducing atmosphere was desired, illuminating gas was admitted in the same fashion.

The kiln was heated to firing temperature in six hours, as this rapid heating had no damaging effects on briquets of these dimensions. Two-hour soaking periods at firing temperature were enough to show the effect of any change in the kiln atmosphere.

Three complete sets of brick were made from each of the 37 batches enumerated above. Group "A" was fired in an oxidizing atmosphere throughout; Group "B" was fired in an oxidizing atmosphere to 1700°F and was finished in a reducing atmosphere; and Group "C" was fired in an oxidizing atmosphere to 1700°F, then in a reducing atmosphere to the firing temperature, and finished in an oxidizing atmosphere.

Results

(1) All of these brick except those made of Starr County Texas clay reacted in the same general way with the additions. The Starr County clay because of its low firing temperature was not heated to the point at which the additions would react with the clay and the color of the finished brick was unaffected by the addition.

(2) The deciding factor in determining the background color of a clay brick is the atmospheric condition of the kiln at the end of the firing. A brick without colorants will have a buff color when the firing is finished oxidizing, but a gray color when the firing is finished reducing. By changing from oxidizing to reducing conditions at the finishing temperature, it is possible to change the brick color from buff to gray,

or vice-versa, and by regulating conditions at the end of the firing any shade between buff and gray can be obtained.

The chemistry of this color change is simple. After the organic matter has been oxidized, the color of the brick is determined by the state of oxidation of the iron contained in the clay. If fired in an oxidizing atmosphere and the iron is present as Fe_2O_3 a buff color is obtained. But when the brick are fired in a reducing atmosphere, the iron is present in a partly reduced state, and the lower oxides of iron cause the gray or blue-gray color of the brick.

(3) Brick fired in a continuously reducing atmosphere are black in color. This is due to the fact that the clay contains organic matter which is not oxidized but which is decomposed, leaving a residue of carbon throughout the brick. This carbonaceous material may be a cause of flashing and this point will be discussed with the other causes of flashing.

(4) Brick containing up to 0.5% of 325-mesh manganese ore, when fired in an oxidizing atmosphere, are buff colored, a little more gray or grayish-brown in color than the same brick without colorant. In a reducing atmosphere at the end of the firing these brick are a deeper gray than the same brick without colorant. The effects produced by small quantities of this material are very marked and more than 0.5% produces a very undesirable brown color. Fortunately the amount of such fine material in commercial grinds of ore is not large enough to have this effect.

(5) Additions of 325-mesh Imperial Gray give the brick a gray color, which is deeper under reducing conditions. Additions up to 1.5% produce desired colors.

(6) The size of the particles of Imperial Gray makes no difference in the color produced except in the case of the air-floated material. This can be explained by the fact that mixtures of clay and Imperial Gray are infusible at the firing temperature of the clay. Therefore, all brick containing 1% of Imperial Gray show approximately the same color, regardless of the size of the particles of the colorant. There is a slight difference in color, due to the fact that the larger size particles can not be so thoroughly distributed. The effect of the sized particles of manganese ore is very marked, and these effects make the screen analysis of the added manganese ore a very important factor.

(7) The tinctorial power of any addition is proportional to its exposed surface, and this may be enlarged considerably by a chemical reaction with the body of the brick.

(8) When specimens containing granulations of very definitely-sized manganese particles, are fired in the kiln in an oxidizing atmosphere, the background of the brick is buff in color, and the spots small

and sharp in outline. Even in the case of 200- to 250-mesh material the spots are distinct and the background is not discolored. This indicates that for background coloring, very fine material, such as 325-mesh is necessary.

Finished in a reducing atmosphere the background is gray, matching perfectly the color of a brick made of the same clay without any additions. The spots, however, are now large, round spots instead of the small, sharp spots produced by the same colorant under oxidizing conditions. In this case there is another difference in that the spots have a brownish appearance. This is caused by the fact that the finishing temperature is equal to or higher than the temperature at which clay and manganese fuse under reducing conditions. A study of these brick showed that 60- to 80-mesh particles, when held in a reducing atmosphere near the finishing temperature give as large spots as 20- to 40-mesh material in an oxidizing atmosphere. The advantage of using 60- to 80-mesh material instead of 20- to 40-mesh material is very easily seen. The average dimension of 60- to 80- mesh particles is 0.0084 inch, while the average dimension of 20- to 40-mesh material is 0.0249 inch. Since the exposed surface varies with the cube of the average dimension, there is twenty-seven times as much surface exposed when the 60- to 80-mesh material is used, and a correspondingly greater amount of color is produced. Since the spots are the same size, one can use one twenty-seventh the amount of the finer material and still obtain the same effect.

(9) As might be expected when commercial grinds of material are used, the number and size of the spots depend on the particle-size ratio of the colorant, while the background color is influenced by the percentage of fines. By carefully choosing the commercial grind of manganese ore and controlling firing conditions, any desired shade of speckled brick can be made.

Summary

In summarizing the results of these tests, due consideration is given to the fact that there is a vast difference between laboratory control and plant operation, inasmuch as the laboratory apparatus is so equipped that the delicate manipulation of temperature and atmospheric conditions is possible. Whereas it was a comparatively simple matter in the laboratory to obtain strongly oxidizing, or strongly reducing conditions by filling the muffle either with air or with illuminating gas, it would be very difficult for the average plant operator to get such a uniformly oxidizing or reducing atmosphere in an entire kiln.

A gray brick can be produced in several ways. After firing in an oxidizing atmosphere without colorant, a gray color can be obtained by

soaking in a reducing atmosphere. A small percentage of air-floated manganese will deepen this color under the same firing conditions.

A black brick is produced when the atmosphere is reducing throughout the firing. This is not commercial.

To get the greatest possible effect of the manganese in making a speckled brick, it is necessary to have the kiln reducing for a part of the firing. These bricks should be in a reducing atmosphere either just before the firing temperature is reached, or they can be soaked in a reducing atmosphere at the firing point. If a brick containing coarse manganese is not reduced the spots will be small and compact. When this same brick is soaked at the finishing temperature in a reducing atmosphere, the manganese fuses with the clay, causing a large round brown spot. Overfiring, or soaking too long, at this stage will cause the manganese spot to pit the surface of the brick. Soaking for too short a time causes the manganese to react, just glazing that spot.

After the spot has been formed under reducing conditions, soaking the brick at the finishing temperature under oxidizing conditions will not change it although the background color will be altered. For this reason it is essential that the firing be reducing for part of the time when a speckled brick is desired.

In the case of clays maturing at temperatures below 1800°, as is the case of the Starr County Texas clay, the addition of a colorant has no effect, because the temperature never reaches the point at which the colorant fuses with the clay, and hence the brick contains a small percentage of unaltered addition which has little effect on its color.

In practice, flashing is caused by reducing conditions during some stage of the firing or by very high temperature effects in part of the kiln. The direct cause of flashing is too high a temperature, and it is possible to uniformly flash an entire kiln of bricks by raising the temperature high enough above the finishing point of the clay. Flashing may occur at various localities in the kiln, even though the average temperature is not above the finishing temperature of the clay.

At relatively high temperatures when fresh coal is being fed into any fire box, the zone controlled by that particular fire box is strongly reducing. The gases in this zone carry hydrocarbons which are decomposed on surface of the hot brick, depositing carbon. After all the volatile matter is removed from the coal and the atmosphere is again oxidizing, the carbon which was deposited on the surface becomes incandescent, and causes a local temperature intensity which flashes the brick. If the atmosphere of the kiln is not strongly oxidizing from approximately 400 to 1700°F and the organic matter is not oxidized at this stage of the firing, it will be oxidized in place at a higher temperature and very likely the heat intensity will cause a flashed brick.

The firing of clay brick can be divided into three stages, the first of which is the removal of the carbonaceous matter from the clay. After the kiln has reached the temperature at which the carbonaceous matter starts to burn, it is essential to maintain an oxidizing atmosphere till all the organic matter is oxidized. During the second stage of the firing the kiln is held reducing for a sufficient period of time to cause the effective area of each individual manganese particle to reach its maximum. The third stage is the finishing stage and upon the atmospheric conditions of the kiln at this time depend the background color of the speckled brick and the color of the straight clay brick. Contrary to the information received from some brick manufacturers, the gray or bluish gray brick is the result of a reducing atmosphere during the third stage of this cycle, and a buff brick is the result of an oxidizing atmosphere during this stage.

Conclusion

A careful study of these results indicates definitely that by careful selection of the particle-size ratio of the colorant and careful regulation of the atmospheric condition of the kiln at the finish of the firing, it is possible for the operator to procure any desired result.

Acknowledgment The authors wish to thank Mr. R. J. Otten for his valuable suggestions and his help in making corrections on this paper.

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THE EFFECT OF INCORRECT DIE ADJUSTMENT UPON DRIER AND KILN LOSSES[1]

By Leslie R. Alt

ABSTRACT

Experiments made to determine the relation of incorrect die regulation to drier and kiln losses which might be attributed to the die, and to determine a method whereby the operator might check the die performance and so regulate the die as to reduce to a minimum the losses due solely to incorrect die adjustment are described and the results discussed.

Introduction

Probably the most common source of loss to the hollow-ware manufacturer is that due to checks which occur in the ware during the drying and firing periods. Unsatisfactory color, scum, limited capacity, and lack of uniformity, are additional troubles, but too frequently drier and kiln losses raise the production cost or lower the average selling price sufficiently to make it impossible to manufacture the ware at a profit.

Assuming that the clay, processing, and manufacturing equipment are suitable for the manufacture of hollow ware, these losses, regardless of the stage of manufacture in which the defects are discovered, must have their origin in one of the following sources: (1) formation at the die, (2) handling to drier cars, (3) drying, (4) firing, and (5) cooling. As a general rule, losses due to unfavorable drier control, firing conditions unsuited to the ware, or too rapid cooling, will develop in that stage of manufacture in which the defects can first be seen. Rough handling by the off-bearers is a common source of loss, but is one in which the evidence is always present. Losses due to this cause are easily corrected.

In tracing losses due to incorrect die adjustment, we are confronted with a somewhat more intangible problem. Very unbalanced dies will show their condition on the moving column by tearing the corners, by splitting, or otherwise distorting the column. A die sufficiently unbalanced to cause excessive drier or kiln loss may, to an observer of the moving column, exhibit no sign of poor regulation. The product of such a die will generally reach the drier in perfect condition and will show no defect until the ware is dry. The size of the checks which will open in this product will depend upon (1) the shrinkage of the material, (2) the amount of stress which unequal shrinkage (due to incorrect die adjustment) sets up in the ware; and (3) the temperature, humidity, and circulation of the drying atmosphere. Under most favorable drying conditions, the product may pass through the drying stage without cracking, the checks opening only under the increased strains due to kiln load and firing shrinkage.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received December 12, 1927.

Unless we know definitely the origin of the defect, we quite naturally attribute the loss to that stage in which we first observe the defect.

Object of Experiments The experiment was made to determine the relation of incorrect die regulation to such losses as might be attributed to the die; and to determine a method whereby the operator might check the die performance, and so regulate the die that losses due solely to incorrect die adjustment may be reduced to a minimum.

General Procedure

Equipment The test blocks were taken from the cutting table of a hollow-ware plant having a normal capacity of 10,000 pieces of 5- by 8- by 12-inch building units or the equivalent in eight hours. Clay was hand shoveled to insure a uniform mixture, ground in dry pans, and delivered to a 14-foot pug mill.

The block machine was a straight barreled machine having a 12-inch, 4-winged propeller which turned 35 r.p.m.

The dies on which the blocks were made are briefly described later in the description of the series.

Observing Die Performance At the time each block was taken from the cutting table, the die performance was observed in the following manner: (1) the block machine was stopped when running near normal capacity; (2) the clay column was cut off flush with the face of the die; (3) the machine was started until about four inches of the column had protruded from the end of the die, and the machine stopped; and (4) fast and slow areas were measured by the distance the area had moved from the face of the die.

Samples for Shrinkage Measurement Each block was cut lengthwise with a fine wire into sections as shown by the dotted lines in Fig. 1. Cutting a 5- by 8- by 12-inch two-celled block in this manner gives 2 sections 8 by 12, 2 sections $3\frac{1}{2}$ by 12, and the web.

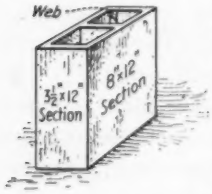

FIG. 1.

Each section was marked at 2-inch intervals with an 8-inch shrinkage gage, numbered, and placed in a drier in a vertical position to prevent warpage. When dry, the shrinkage was measured and recorded.

Per cent shrinkage was calculated on the dry measurement.

Note: A gage is preferable to measuring the length of the section because of the possibility of error due to uneven cuts. A 10-inch or a 12-inch gage will give greater accuracy.

Series A

The die used in this series was a 5- by 8- by 12-inch building block die which had developed a fast center due to badly worn cores. At the time of the test, the side walls measured $^{13}/_{16}$ inch, and the web $^{5}/_{8}$ inch. Both cores and side walls had a taper of $^{1}/_{32}$ inch per inch. Attempts to retard the center by bringing the cores closer together resulted in unfilled webs. Opening the cores to avoid this trouble brought back the fast center.

A $^{1}/_{2}$- by 1 $^{1}/_{4}$-inch tool steel retarder, sharpened at the back was bolted to the die parallel to the bridges and at a distance from the face of the die equal to the distance of the bridges from the face of the die. (See Fig. 2.)

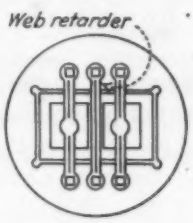

FIG. 2.

Trial of die performance showed that the column had a strong tendency toward a slow web. The web, on a 5-inch protrusion from the face of the die, was $^{1}/_{2}$ inch closer to the die than the 5-inch faces. The web was completely filled, however, and the column perfect as far as could be ascertained.

Two blocks were taken for shrinkage measurement, and the following results were obtained.

DRYING SHRINKAGE: SERIES A

	No. 1		No. 2	
	Linear	(%)	Linear	(%)
Av. outside walls	0.42 in.	5.5	0.41 in.	5.4
Av. webs	0.50 in.	6.6	0.51 in.	6.8

The shrinkage data shows distinctly the unbalanced condition of the die. It will be noted that in both samples, the webs show a linear shrinkage of nearly 0.10 inch more than the outside walls or almost 1%. In a unit 12 inches long, this difference in shrinkage would amount to 0.12 inch which is an appreciable amount to be taken care of in the readjustment of the drying process. These blocks, when dry, showed a distinct concavity at both ends and, in a drying atmosphere more severe than usual, cracked quite badly.

Retarders, such as the one described, are in common use for retarding fast areas. They should be used, however, with caution as it is possible for them to do more harm than good. Their purpose is to decrease the effective pressure on the opening, consequently decreasing the compression of the clay through the opening. This results in an increased shrinkage of the section which is retarded.

Series B

The die used in this series was the same as the one used in Series A with the exception of the cores. New cores were installed and the web

retarder removed. The walls of the die with the new cores measured $^{11}/_{16}$ inch and the web $^{9}/_{16}$ inch. The taper of the cores was not changed.

Trial of die performance showed a slight tendency toward a slow central area. Upon a 4-inch protrusion from the die, the 5-inch faces were $^{1}/_{4}$ inch farther from the face of the die than the web.

Three samples were taken for shrinkage measurement after the die had been run long enough to polish the cores.

DRYING SHRINKAGE: SERIES B

	No. 1		No. 2		No. 3	
	Linear	(%)	Linear	(%)	Linear	(%)
Av. outside walls	0.38 in.	5.0	0.38 in.	5.0	0.36 in.	4.7
Av. web	0.47 in.	6.2	0.41 in.	5.4	0.41 in.	5.4

Sample 1 shows a difference in web and side-wall shrinkage which is out of proportion to the die performance, and a much greater difference then either of the other two samples. However, the average shrinkage of the webs in this series is about 0.06 inch greater than the shrinkage of the side walls or about 0.08%. The shrinkage of these samples is so varied as to make generalizations uncertain except that in all the samples, the greater web shrinkage indicates an unbalanced condition at the die which would make the ensuing stages of manufacture subject to loss.

Series C

The block of this series were made on the die of Series B with the cores separated $^{1}/_{32}$ inch to relieve the retarding action of the central area. This adjustment made the web measure $^{19}/_{32}$ inch, the 5-inch faces $^{43}/_{64}$ inch, and the 8-inch sides $^{11}/_{16}$ inch.

Trial of die performance showed no tendency toward unequal velocities through the die.

DRYING SHRINKAGE: SERIES C

	No. 1		No. 2		No. 3	
	Linear	(%)	Linear	(%)	Linear	(%)
Av. outside walls	0.28 in.	3.6	0.28 in.	3.6	0.31 in	4.0
Av. web	0.31 in.	4.0	0.31 in.	4.0	0.35 in.	4.5

As the die with this adjustment performed very well and the block dried without cracking, it was deemed unnecessary to make further adjustments. It will be noted that there is a slight difference between the web and side-wall shrinkage, the webs shrinking $^{1}/_{2}$ of 1% more than the side walls. This condition is probably preferable to one in which the side wall shrinkage exceeds the web shrinkage. In most installations, the clay is pugged as stiff as the safety pin of the machine will permit to guard against warped block in handling. Consequently, all variations in pugging will be toward a softer column which would tend to speed up the central area, and cause a decreased drying shrinkage of that area.

General Conclusions

Obviously, it is incorrect to draw definite conclusions from a test of this kind, made on one type of equipment and with one clay, there being so many factors of die performance that vary with the manufacturing equipment and the raw materials. This paper has for its purpose, however, the development of a method of detecting and correcting die troubles, rather than to give definite data concerning them.

In investigating the origin of drier and kiln losses which may be caused by incorrect die performance, the construction of the die itself should first be considered. Bridge cracks, which are a common cause of loss, are quite easily detected because of their repeated occurrence in the same place in the ware, *i.e.*, where the bridge or bridges cut the column prior to its formation at the die. The remedy for this trouble is to give the clay a better chance to reunite by setting the bridges back from the die, by using corrugated bridges, or both.

Warping or weaving of the column as it leaves the die is due to the varying pressure of the revolving propeller wings and may result in loss by cross-checks, and by warped and crooked ware. This trouble has been found to act differently with different positions of the core bridges, and decrease as the number of wings on the propeller is increased. When horizontal bridges are used, the column will have a vertical weave. Often the weight of the column is sufficient to remove the irregularity. In some cases a light roller has been used to advantage to straighten the column. When vertical bridges are used, however, the weave is lateral and difficult to remove. The proper remedy in either case is to increase the distance between the die and the auger.

The length and taper of the cores and die-walls, the type of scorers to be used, the extent of lubrication, and the size of the openings, are phases of die construction which may cause die losses but which vary with each type of equipment and with each clay.

The method, as outlined in this paper, of correcting die performance assumes that all drier and kiln losses which occur as a direct result of incorrect die adjustment, are due to the unequal shrinkage of the sections of the ware; and that the unequal shrinkage is a direct result of the unequal compression as the clay is formed by the die. Stresses due to formation are not considered because (1) in case of excessive stresses of this nature, an immediate fracture will be discernible and the fault remedied at once; (2) minor stresses of this nature will relieve themselves without fracture by adjustment before drying begins due to the mobility of the clay in the plastic state.

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THE DESIGN OF HOLLOW TILE DIES[1]

By A. F. Greaves-Walker[2]

ABSTRACT

The die problem is stated in terms of plant experience. Questions of piston vs. auger pressure, dimensional relations, speeds, uniformity of feed, die shape, position and dimension of bridges, posts, and cores are discussed in relation to varying clay characteristics.

Introduction

Most manufacturers of hollow ware consider the die to be the most important single item of equipment. Upon it depends the important functions of forming the ware with the desired finish, structure, and size.

Dies necessarily vary in design and construction, but there is no question that in many respects they can be standardized.

Due to the extent of the undertaking and the almost unlimited number of variables, practically no research data are available. It is a problem which a Government bureau could best undertake, and one which would yield valuable results.

Sewer Pipe Press and Dies

The sewer pipe press is the simplest hollow ware machine. It is remarkable to note the similarity or lack of deviation from a standard design in sewer pipe dies even though the clays used differ widely in physical qualities. Three important points common to all sewer pipe dies should be noted by the manufacturer of other types of hollow ware: (1) they have a straight issue, *i.e.* are not tapered; (2) they are dry dies; (3) the material forced through them is pugged until its best working qualities are produced.

The top of the bell or core is tapered, but this is necessitated by the construction of the machine rather than of the die. It is true however that the taper or angle of the top of the bell is varied with different materials; in fact, it is the one variable most often encountered in sewer pipe die design.

That the ease with which pipe are run through a die is not due to the simplicity of shape is demonstrated by the fact that the most difficult of all hollow ware, electrical conduits, are made on presses, and for a long period all hollow ware was made by this process.

Hollow Tile Machine

The hollow tile auger machine is a development of the brick machine with a tapered nozzle or front. It appears to have been some years

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received December 17, 1927.

[2] North Carolina State College, Raleigh, N. C.

after the auger machine was first used in the production of tile before machine designers, copying the sewer pipe press, brought out machines especially designed for hollow tile, with straight barrels. These designers probably did not realize at the time how closely they were approaching what will prove to be the ideal barrel design for all stiff-mud products.

Besides the design of the barrel there are a number of other machine factors which have an important bearing on the design and construction of dies. Among these are (1) speed of auger, (2) design of auger, (3) uniformity of feed, and (4) distance from auger to die. In addition to the above, screening or fineness of grain and pugging are important factors.

Auger Speed The great number of hollow tile sizes and shapes, having cross-sectional areas ranging from 20 to over 300 square inches, make the determination of the best auger speeds somewhat difficult. When a machine is driven too fast for a large die it invariably develops fast and slow spots which are hard to control. This is due to lack of sufficient compression in front of the auger to give uniform pressure over the whole die. It is therefore necessary, when only one machine is available, to operate at such a speed as will conform to the requirements of the largest dies. This often means a considerable sacrifice in tonnage on the smaller sizes.

For large tile the auger speed recommended is from 18 to 20 r.p.m.; for the small sizes it may be as high as 30 r.p.m. with 20 to 25 as the average practice. In terms of column speed these auger speeds would give approximately 10 feet per minute for the large sizes and 20 feet per minute for the smaller. With some clays, small simple tile such as 5- by 8- by 12-inches can be run at column speeds as high as 30 feet per minute.

Auger Design Double and triple winged augers are used in hollow tile machines, the double wing predominating. Theoretically the triple wing should give the most uniform pressure at the die but the amount of metal in the tip displaces considerable clay and the increased metal surface adds very considerably to the power required.

The diameter of the auger should remain constant, with the pitch sometimes remaining constant but generally increasing.

In a hollow tile machine the auger must fit the barrel or liners as nearly as possible and still have clearance if unbalanced dies are to be avoided. Space between auger and liners releases the pressure at the corners of the die, points which are always slow and inclined to drag, by allowing the clay to slip or work back toward the feed end. The wear at the circumference of an auger constantly throws a die out of balance

and makes it necessary to slow up the center. When the distance between auger and liner exceeds $^1/_2$ inch the auger should be renewed.

Uniformity of Feed Uniformity of feed is an important factor in keeping dies balanced. This is usually accomplished by means of a forced feed at the hopper. Lack of such an attachment often results in varying pressure in front of the auger which in turn makes a die run erratically.

Distance of Die from Auger A reservoir of clay is necessary between auger and die in order to get uniform flow from a die and also to prevent the auger from transmitting a weaving motion to the column as it issues from the mouth. The length of the reservoir is regulated by inserting rings between die and barrel or by using a telescopic front. The larger the tile the larger must be the reservoir but since the power required to operate the machine increases as the distance between auger and die, it is important to keep it at a minimum. Only by experimenting with each die can the correct distance be determined.

Fineness of Grain and Tempering Shales and fire clays require fine grinding and considerable tempering or pugging to bring out their best working qualities. In no other industry is grinding as important on account of its effect on the dies. Coarse material will not slip over unlubricated steel surfaces as will fine material; even a small percentage of coarse grains will increase the friction sufficiently to perceptibly reduce the column speed. In observed cases a small hole developing in a screen has reduced column speed as much as 25%. This naturally has a decided effect on the balance of a die as the sections presenting the largest surface in relation to the mass are slowed up most.

The importance of tempering is demonstrated by sewer pipe dies or hollow tile dies on a sewer pipe press. No other piece of equipment compares with the wet pan as a tempering machine. The pug mill can only be made to approach it by using a long tub, double shafts, special devices, or a number of mills in series.

Types of Dies Hollow ware dies may be divided into two types, viz: short or flat, and long mouth dies. The flat dies are always dry while the long mouth may be either dry or lubricated.

Length of Die There is a considerable difference in opinion as to whether the long or short type gives best results and as raw materials and preparation differ so widely no definite conclusions can be reached. It can safely be said however, that the majority of clays, when well prepared will work more efficiently on a short die. The length of die required under any given set of conditions depends largely on column speed. As an illustration of the effect of column

speed the die can be compared with a hose nozzle. If a short nozzle is used, an unbroken column of water will issue from it at low pressures. If the pressure is increased beyond a certain point, the column will break at or near the nozzle mouth. In order to keep the column unbroken the length of the nozzle must be increased as the pressure increases, which explains the exceedingly long nozzles used on high pressure fire hose.

Hollow ware column speeds vary greatly according to the size of tile but in no case are they high except possibly on some very small sizes. As many clays will run at the highest column speeds obtained on dies that do not exceed $2^1/_2$ inches in thickness, it seems reasonable to presume that dies 6 and 8 inches long are unnecessary in any case and especially on large sizes.

As the correct length can be determined only experimentally and as dies of the flat type, only $2^1/_4$ inches thick, are successfully operated it would seem advisable to start with that figure. Extensions or mouths of any thickness can be added to the die front until the minimum for good operation is reached. The general rule is that the highly plastic clays will give best results on short dies.

The short dies are not only simpler and cheaper to construct because the bridges, posts, and core stems can be made lighter, but, on account of offering less friction, they can be operated with less power. Long dies, too, are often difficult to keep in balance because cores become sprung due to their length.

Taper The question of correct taper is related to the length. If a long die is used it can have considerable taper; but in a short one, taper has to be eliminated or the column has a tendency to "spray" or expand on issuing. In Stull's[8] work on brick dies, he determined the proper taper to be from $^1/_8$ to $^1/_4$ inch per foot. Under any circumstances this should not be exceeded in a hollow ware die.

Clay when wet has a certain elasticity and any compression beyond a certain point will cause a column to swell or expand upon issuing. This swelling develops a poor structure and results in a weakening of the comparatively thin webs and walls. Too much taper is also wasteful of power and reduces column speed.

A short die may be originally built with a straight issue, *i.e.* no taper. After a few hundred tons of ware have been run through it, taper is produced. Up to a certain point such a die will give slightly increasing column speed and then slow down. It is when this slowing action takes place that the maximum taper for most efficient operation has been passed.

[8] R. T. Stull, "Flow of Plastic Clay through Dies," *Trans. Amer. Ceram. Soc.*, **11**, 450 (1909).

Lubrication Occasionally plants use steam or oil lubricated dies. The plants however, using dry dies are in such majority that it would appear the lubrication of a hollow ware die is unnecessary. The lubricated die is a complicated and expensive piece of equipment that should be avoided if possible. In the majority of cases where it is used the need is not so much for lubrication as for an improvement in die design.

Bridges, Posts, and Cores Every hollow ware manufacturer has at some time experienced "bridge cracks," cracks appearing after the product is dried or fired. These are caused by placing the bridges too close to the mouth of the die. When clay is parted by the bridges it must be given a certain distance in which to knit or bond. Clays vary so much in their ability to bond that the correct distance must be determined for each. Some will make a good bond in 1 inch, others require 4 to 6 inches. Usually highly colloidal clays require the greatest distance from bridge to mouth of die.

With clays which do not readily bond it is often necessary to serrate or "saw tooth" the sides of the bridges so as to roughen the parted surfaces. Wrapping the bridges with fine steel chain accomplishes the same result but chain is subjected to rapid wear and requires constant replacement.

As the metal in the bridges, posts, and core stems interferes with the flow of clay and therefore reduces column speed, it should always be made as light as possible. Stream lining the bridges and cores aids materially in increasing column speed. The use of steel castings or a good grade of steel bars will permit all of these parts to be made lighter than if cast iron were used.

Balancing Dies Obviously the relative thickness of the different walls and webs has much to do with the uniform flow of clay through a die. It is obvious also, that as the clay is expressed at a higher rate of speed in the center of the barrel, the flow at the center of the die will also be at a higher rate than at the outside. This is counteracted in part by the friction on bridges and cores.

Fast flow in the center of a die is usually corrected by metal baffles or plates fastened in such position as to divert the clay from the affected area. It is much simpler to reduce the thickness of the walls or webs in the fast area or increase their thickness in the slow area. This can be easily done by putting a thin metal shim on the cores or taking a thin cut on them. The amount of shimming or cutting necessary is usually so small as to be unnoticeable. In cases where it is necessary to maintain certain minimum weights, thereby preventing a reduction in thickness of walls or webs, the weight can be maintained by shimming in the fast areas and cutting in the slow or by merely increasing the thickness in the slow areas.

Scorers can be used to advantage in balancing a die. When used as liners in the die mouth the placing of the grooves closer together in the fast areas or vice versa in the slow areas will often have the desired effect.

When the scorers are attached to the face of the die they may be made in short sections and slotted so as to make them adjustable. Increasing or decreasing the number of grooves in any given area or adjusting the sections so as to make a deeper or shallower groove, as the case may require, will invariably solve the problem in the walls.

The arrangement of the bridges and posts is very important. They can often be so located as to act as baffles in fast areas.

Die Wear Reduction of die wear is important in hollow ware dies. Some effort has been made to reduce die wear by using renewable scorers as liners, but very little effort has been made to reduce wear on the cores.

The entire die can be so constructed as to use tool steel liners, tempered to glass hardness, on all surfaces exposed to wear. These liners may be quite thin, 1/4 inch, and fastened with machine screws having the heads countersunk. Not only will such liners reduce die wear and the necessity for constant adjustment but by replacing them the die is practically rebuilt. As it is difficult to temper thin liners of considerable length the longer dimensions may be lined with short sections. One of the very decided advantages of liners is that a die can be very quickly balanced by either shimming or using a slightly thicker liner.

Hollow ware dies present an interesting subject for study and investigation. As no attempt has been made at standardization, each manufacturer should analyze his own problems and by intelligent experimenting based on available data, develop the type and design best suited to his own raw material and conditions.

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SOME EXPERIMENTS ON TERRA COTTA SLIPS[1]

By E. C. Hill

ABSTRACT

A series of experiments on slips for terra cotta, in which variations in composition in relation to their effect on vitrification, crazing, cracking, and color are studied.

Introduction

All of the tight-firing New Jersey clays that the writer has tested in a terra cotta body have shown a tendency to produce crazing in the slip or glaze. Since it seems desirable to use as much tight-firing clay as possible, without producing excessive shrinkage or warping in the body, some experiments were made to determine primarily the effect of the composition of slips on their tendency to craze.

First Experiment

The body used contained 60% clay and 40% grog through 16-mesh. Seventy per cent of the clay content was New Jersey tight-firing clays. The trials were in the form of pyramids with a base 12 inches square and 2 inches high. The total height of the pyramid was 5 inches. Four trials were made for each slip tested. These were fired to cone 6, two of each in a 40-ton terra cotta kiln, and two in a 20-ton kiln. The slips were weighed separately in 50-ounce batches and blunged by grinding for one hour with water in laboratory jar mills. They were sprayed on the trials to give a heavy coat.

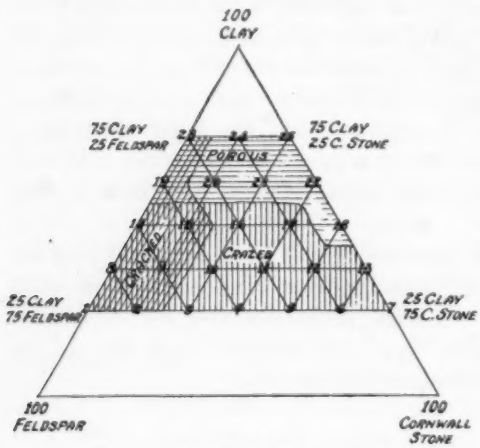

FIG. 1.—Vertical Lines: crazed
Horizontal lines: porous
Diagonal lines: cracked

The material used was (1) United Clay Mines "Exeter" English china clay, (2) Mandle-Porter C1 Kentucky ball clay, (3) Moore & Munger wet ground Cornwall stone, and (4) Genesee Feldspar Co., Canadian feldspar.

Results The compositions of the first series of slips tested are shown in Fig. 1. They have been exposed to the weather six months. The clay content was made up of equal parts of Kentucky ball clay and English china clay.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Terra Cotta Division.)

All of the slips with 25% clay were vitreous, and had considerable sheen, the sheen decreasing with increase of Cornwall stone. The high feldspar slips were pinkish in tone, the color changing to white with increase of Cornwall stone. The high Cornwall stone slips had a good white color.

The slips with 37½% clay are all mature except the clay-Cornwall stone slip, two of the four trials being immature. The maturity was determined by applying ink to the trial allowing it to dry, and washing off with water. Trials showing an ink stain after washing were considered immature.

Slips with 62½% clay were all immature. The slip with 62½% clay and 37½% feldspar had two of four trails immature, while all trials of the other slips were immature, those with 75% clay being quite porous.

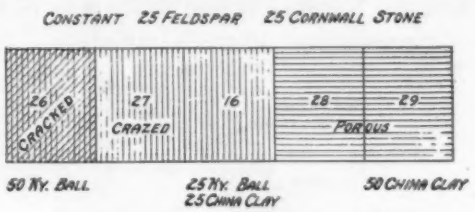

FIG. 2.—Vertical lines: crazed
Horizontal lines: porous
Diagonal lines: cracked

All of the feldspar-clay slips had a tendency to crack. The cracks were larger with high feldspar slips, but the number of cracks was about the same in all the trials. Increasing Cornwall stone overcame the tendency to crack.

All of the slips with 50% or less clay crazed, except the one with 50% clay and 50% Cornwall stone. The crazing decreases decidedly with increase of clay, but also decreases with increase of Cornwall stone.

There was a number of slips in this series that had satisfactory color and texture, but they either had a tendency to craze or become immature.

The Kentucky ball and the English china clays were varied in a series of slips shown in Fig. 2. The trials were made from the same body and fired in the same kilns as the slips shown in Fig. 1.

The ball clay slip was buffish in tone, the slips becoming whiter with increase of china clay. The ball clay slip was cracked. Cracking decreases with increase of china clay. Slips with half ball clay or more are mature. The slip with 37½% china clay has two of four trials immature, and the slip with all china clay has all trials immature. Trials with 25% or more ball clay are crazed. Increasing china clay decreases crazing.

Second Experiment

As no satisfactory slips were developed on this body with the compositions shown in Figs. 1 and 2, another body was prepared which contained 60% New Jersey tight-firing clay of the total clay content.

Trials were made as before, with the composition of the slips as shown in Fig. 3. The slips with 50% clay were tested again on this body, and two series containing clay above and below this amount, intermediate with those shown in Fig. 1.

Results All slips with 43.75% clay were mature. With 50% clay, the two slips highest in feldspar are mature, but numbers 16 and 17 had two of four trials immature and the high Cornwall stone slip had all trials immature. Numbers 16 and 17 were mature when tested in Series 1. With 56.25% clay, only the high feldspar slip is mature. Number 36 had two of four trials immature and the remainder of the series had all trials immature.

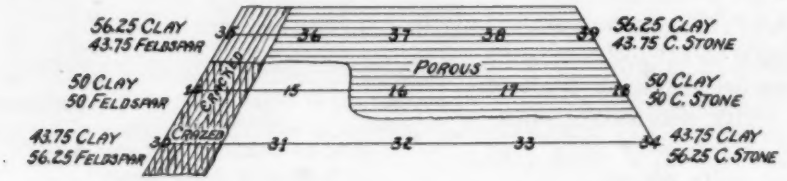

FIG. 3.—Vertical lines: crazed; horizontal lines: porous; diagonal lines: cracked.

As in Fig. 1, the clay-feldspar slips showed a tendency to crack. Crazing occurred with the clay-feldspar slips containing 50% or less clay. Numbers 15 to 17 were free from crazing on this body, but were crazed on the body shown by Fig. 1. The satisfactory slips are shown on the untouched area of the diagram. The slip containing 43.75% clay, and equal amounts of feldspar and Cornwall stone, is probably the safest of any slip developed in these experiments, since it is about equally removed from crazing and cracking on the one hand and from immaturity on the other.

Summary

Vitrification: Decreasing clay is the most effective method of increasing vitrification. Vitrification may be increased by increasing feldspar and reducing Cornwall stone and by increasing ball clay and decreasing china clay.

Crazing: Increasing clay is the most effective method of overcoming crazing. Crazing may be reduced by substituting Cornwall stone for feldspar and china clay for ball clay.

Cracking: Increasing Cornwall stone is the most effective method of overcoming cracking. Substituting china clay for ball clay reduces cracking.

Color: The whiteness of the slips can be increased by increasing clay, substituting Cornwall stone for feldspar and china clay for ball clay.

Acknowledgment The writer wishes to acknowledge the investigations made along similar lines by Stull[2] and by Davis and Lathrop.[3] The materials used, however, and the specific compositions tested in those investigations, differed enough from these experiments to justify presenting these data.

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[2] R. T. Stull, "Notes on the Manufacture of Enamel Brick with Some Investigations on Enamel Brick Slips," *Trans. Amer. Ceram. Soc.*, **12**, 711–65 (1910).

[3] H. E. Davis and J. S. Lathrop, "A Study of Slips for Standard Finish Terra Cotta (Cones 4–5)," *Jour. Amer. Ceram. Soc.*, **8** [1], 24–28 (1925).

THE RELATIVE IMPORTANCE OF ERRORS OF SAMPLING AND MEASUREMENT IN CERAMIC RESEARCH[1]

By A. E. R. Westman

ABSTRACT

The common use of average values based on measurements of a small sample of specimens in ceramic research is pointed out. The principal errors to which such averages are subject are described and the need for a method for proportioning sampling errors and errors of measurement shown. An equation giving the relation between sampling errors and errors of measurement is derived by expression of factors involved in statistical terms and combination of well-known statistical equations. This equation is used for constructing a chart by means of which questions involving sampling errors and errors of measurement can be readily solved. This chart also enables one to visualize the rôles played by sampling errors and errors of measurement in determining the accuracy of an average. The general applicability of the method is pointed out and its theoretical limitations are discussed.

I. Introduction

(1) Use of Average Values in Ceramic Research

In ceramic research we frequently speak of large groups of materials or products as though they were individual specimens. Thus we commonly use such phrases as "the porosity of a brand of bricks" or "the strength of a porcelain body," and are apt to forget that we are talking about large groups within which appreciable variation in properties is to be expected. By the porosity of a brand of bricks we usually mean the average porosity which would be obtained by measurement of a very large number of bricks of the brand in question. When we wish to determine the porosity of a brand of bricks in the laboratory, however, we actually determine the average value for a sample consisting of only a relatively small number of specimens.

If we leave out of consideration constant errors and systematic errors,[2] such an average value is subject to two important groups of errors, *viz.*, errors of measurement and errors of sampling. The accuracy with which this average value characterizes the whole brand of bricks will depend on the extent to which the effects of these errors are reduced. The errors of measurement are the errors involved in determining the porosity of any one specimen and depend on the accuracy of the method, the precision of the apparatus, and the skill of the observer; the errors of sampling are due to the variation in porosity from speci-

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Refractories Division.)

[2] Constant errors tend to make all values too low or too high by a definite amount; systematic errors vary continually in accordance with certain uncontrolled factors such as room temperature, barometric pressure, etc.; constant errors are often minimized in engineering tests by definition, calibration, and standardization, systematic errors by the use of corrections or comparative methods.

men to specimen of the brand in question and to the use of an average value obtained from measurement of a few specimens to characterize a whole brand.

It is not infrequently the case that an attempt is made to increase the accuracy of an average value by decreasing the errors of measurement and leaving the sampling errors unchanged. In many cases it is impossible to secure the desired accuracy by this procedure; in other cases accuracy could be secured more economically by a reduction in sampling errors. Considerable effort could be saved if the rôles played by these errors were better understood.

In planning a ceramic investigation, it is frequently necessary to form some estimate of the number of specimens of the various products or materials which will be needed in determining their properties with the required accuracy. Such an estimate can be made in a systematic manner from available data or from preliminary experiments when the effects of the different errors are known.

(2) Purpose of this Paper It is the purpose of this paper to show how statistical methods can be used to determine the relationship which exists between errors of measurement, errors of sampling, and the error of an average; to present a chart by means of which an understanding of the relative importance of errors of measurement and sampling can be easily obtained, and to show how this chart can be used in solving sampling problems.

II. Derivation of Relationship

(3) Factors Involved In order to simplify the discussion, let us consider the problem of determining the porosity of a brand of bricks. As far as the investigator is concerned, the following factors have to be taken into consideration: (*a*) the desired accuracy of the average value, (*b*) the variability of the porosities of the bricks of the brand in question, (*c*) the errors of measurement, (*d*) the errors of sampling, and (*e*) the actual accuracy of the average value. Factor (*a*) is generally fixed by the nature and object of the investigation; factor (*b*) is a property of the brand in question and is therefore fixed; factor (*c*) can be varied by the experimenter; factor (*d*) depends on the number of specimens used, assuming random sampling from a normal population,[3] and can also be varied; and factor (*e*) will depend on factors (*b*), (*c*), and (*d*).

(4) Definition of Terms and Symbols If we assume that the porosities of the brand of bricks are distributed normally and that the errors of measurement are random in nature, it

[3] See previous paper, *Jour. Amer. Ceram. Soc.*, **10** [3], 139 (1927).

is possible to express factors (*a*), (*b*), (*c*), and (*e*) as standard deviations[4] and in this way permit the direct application of statistical equations. In the following development, standard deviations will be represented by the symbol σ, the different standard deviations being distinguished by means of subscripts. In order to simplify the formulas, it will be assumed that they are calculated from a large number of values using the ordinary formula[4] or from a small number of values using the Small Sample formulas of Pearson.[5] For normal distributions they will then give the range within which we can expect 68.3% of a large number of similarly obtained values to fall. The standard deviations multiplied by 0.6745 give the corresponding probable errors or 50% ranges.

We will let σ_T be the true standard deviation of the porosities of the bricks of the brand in question, σ_O be the observed standard deviation of these porosities when they are determined by a method of measurement for which σ_E is the standard deviation of the values obtained by repeated measurement of any one brick, and σ_A be the standard deviation of the average value obtained from measurement of a sample of n specimens. Thus σ_T represents factor (*b*), σ_E factor (*c*), n represents factor (*d*), and σ_A factor (*e*).

(5) Derivation of Equation. The value of σ_O is not, in general, equal to σ_T but is given by the equation[6]

$$(1) \quad \sigma_O^2 = \sigma_T^2 + \sigma_E^2$$

The value for σ_A is given by the equation

$$(2) \quad \sigma_A^2 = \sigma_O^2/n$$

By combining these equations and solving for n we obtain

$$(3) \quad n = (\sigma_T^2 + \sigma_E^2)/\sigma_A^2$$

Since σ_T, the true standard deviation of the porosities of the brand of bricks in question, is fixed, we can take advantage of a general property of standard deviations[7] and express σ_E and σ_A in terms of σ_T, reducing equation (3) to

$$(4) \quad n = (1 + \sigma_E^2)/\sigma_A^2$$

where σ_E and σ_A are expressed in terms of σ_T.

Equation (4) provides us with a relation between the number of

[4] Consult texts on statistics for a definition of standard deviation.

[5] The formulas involved and charts for ready calculation are given by Shewhart, *Bell System Tech. Jour.*, 5 [2], 308–19 (1926).

[6] See "Introduction to the Theory of Statistics," G. Udney Yule, and "The Correction of Data for Errors of Measurement," W. A. Shewhart, *Bell System Tech. Jour.*, 5 [1], 11–26 (1926).

[7] If the unit which is used in the values under consideration is doubled, the standard deviation is doubled.

specimens n, the standard deviation or error of measurement σ_E, and the standard deviation or error of the average σ_A. In other words we have a relation between sampling errors, errors of measurement, and the error of an average.

III. Graphical Representation

(6) Description of Chart The chart shown in Fig. 1 was constructed by means of equation (4) given in the previous section, and shows the relationship between the number of specimens n, the standard deviation of the average σ_A, and the standard deviation of measurement σ_E for values of n from 1 to 140, of σ_A from 0.1 σ_T to 1.0 σ_T, and of σ_E from 0 to 2.0 σ_T. It thus covers the field for which the errors of measurement are not more than twice the variability of the product under consideration, the desired accuracy of the average is greater than the uniformity of the product, and samples consisting of less than 140 specimens are used. A large proportion of the measurements of the properties of ceramic products comes within this field.

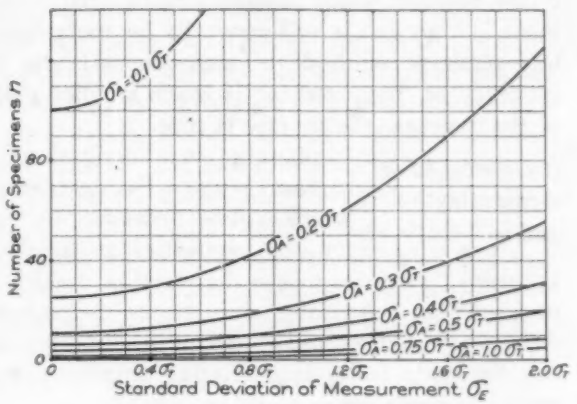

FIG. 1

In the figure, values of σ_E, expressed in terms of σ_T, are given by the horizontal scale; values of n, the number of specimens, are shown on the vertical scale; and curves showing the relation between these two quantities for different values of σ_A, expressed in terms of σ_T, are drawn.

(7) Use of Chart The way in which the chart is read can best be shown by an example. Let us suppose (*a*) that we wish to obtain an average value for the porosity of a brand of bricks which will have a standard deviation, σ_A, equal to ± 1.0; (*b*) that our method of measurement gives a standard deviation, σ_E, equal to ± 2.5 for repeated measurements of one specimen; (*c*) that the true standard deviation of the porosities of the bricks, σ_T, is ± 5.0; and (*d*) that we wish to know the number of specimens which should be used. Expressing σ_A and σ_E in terms of σ_T we obtain the values 0.2 and 0.5 respectively. The junction of the curve for $\sigma_A = 0.2$ and the ordinate for

$\sigma_E = 0.5$ on the chart gives the value $n = 31$, which shows that at least 31 specimens would be needed under the described conditions.

(8) Qualitative Conclusions Some interesting qualitative conclusions can be drawn from an examination of the general shape and position of the curves shown in Fig. 1. The spacing of the curves along the perpendicular axis, for instance, shows that for $\sigma_A = \sigma_T$, n is greater than 1 even when errors of measurement are entirely eliminated, and increases rapidly as σ_A decreases. In other words, when the accuracy desired is greater than the uniformity of the product, sampling errors are very important and cannot be overcome by increasing the accuracy of measurement.

For $\sigma_A = \sigma_T$, one specimen may be sufficient if σ_E is sufficiently small, but, since a relatively large increase in σ_E can be readily offset by an increase in n, it will usually be more economical to use several specimens. The latter is particularly true if σ_E is smaller than σ_T. In other words, when the accuracy desired is not greater than the uniformity of the product, small samples can be used if the accuracy of measurement is high but it will generally be more economical to use quicker, less accurate methods of measurement and larger samples. If the accuracy of measurement is much smaller than the desired accuracy of the average, the reverse is true.

(9) Methods of Estimating σ_E and σ_T In planning an investigation it is frequently necessary to form some estimate of the number of specimens which will be necessary to enable average values for various properties to be determined with a given accuracy. In order to use the chart in making this estimate, it is first necessary to form some estimate of the values of σ_E and σ_T for the different properties and groups of products considered. These estimates can be made from data relating to tests of similar materials or by means of preliminary tests.

The standard deviation of measurement, σ_E, for a particular method and apparatus can be determined from data giving the results of repeated measurements of one specimen or from the values obtained from a series of duplicate or triplicate measurements. Where the properties measured are such that repeated measurements are not possible, *e.g.*, in transverse strength tests, an estimate of σ_E can be made by an analysis of the steps involved in a measurement and the application of the theory of propagation of errors, or by the measurement of a number of specimens of a material which is known to be very uniform in its properties. Where each specimen is itself a group of individuals, the calculation of σ_E is particularly easy. This would be the case, for instance, if we were determining the average porosity of a large number of brands of brick.

The true standard deviation σ_T for the properties of the individuals forming the group or brand under consideration can be estimated from previous data obtained with the same or similar materials when the standard deviation of the methods of measurement used is known to be small. It can frequently be estimated from a series of preliminary experiments using a method whose accuracy is known or is very high, equation (1), section 5, being used for correcting for errors of measurement. It would be a great help in ceramic research if values of σ_T for a number of the common properties of important ceramic materials and products were determined and tabulated.

In most of the above methods of estimation, very good use can be made of the Small Sample Theory of "Student" and Pearson,[5] and occasionally the chart given in Fig. 1 can be used in determining σ_T from previous data for which σ_A, n, and σ_E are given. Accurate estimates of σ_E and σ_T are seldom needed.

IV. Applicability of Method

(10) Generality Although, in order to simplify the discussion, we have used the particular case of the determination of the porosity of a brand of bricks as an example, the chart shown in Fig. 1 can be used in solving a great variety of problems into which errors of measurement and sampling enter. In every case in which we are dealing with a large group or population of objects (or values), the determination of the properties (or magnitudes) of which are subject to error, the same method can be applied. The chart can be used, for instance, (*a*) to determine the number of observers which should be used in certain tests in order to eliminate personal equation; (*b*) to determine the errors involved in finding the average screen analysis of a mineral deposit; (*c*) to determine whether it is better, in a particular instance, to increase the accuracy of measurement or to make duplicate or triplicate determinations; and (*d*) in a large number of situations which, at first appear to have nothing in common.

(11) Limitations In the foregoing discussion it was assumed that the population or group under discussion was normal,[8] that random sampling had been secured, and that the errors of measurement were distributed normally and not correlated with the values obtained. In actual practice these assumptions do not limit the usefulness of the method very much because they are approximately true for most engineering tests,[8] very precise values for the quantities involved are seldom required and considerable violation of the assumptions can occur without greatly influencing the accuracy of the values obtained by means of the chart.

[8] Distributions may be approximately normal in the usual sense of the term "approximate" and yet give very low values for the "goodness of fit" criterion.

V. Summary

(12) Averages and Their Errors The common use of average values based on measurements of a small sample of specimens in ceramic research has been pointed out. The principal errors to which such averages are subject have been described and the need for a method for proportioning sampling errors and errors of measurement shown.

(13) Equation By expressing the factors involved in a typical situation in statistical terms and combining well-known statistical equations, an equation giving the relation between sampling errors and errors of measurement has been obtained.

(14) Chart The foregoing equation has been used for constructing a chart by means of which questions involving sampling errors and errors of measurement can be readily solved. This chart also enables one to visualize the rôles played by sampling errors and errors of measurement in determining the accuracy of an average.

(15) Applicability The general applicability of the method has been pointed out and its theoretical limitations have been discussed.

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CERAMIC ABSTRACTS

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Vol. 7 April, 1928 No. 4

Author Index to Ceramic Abstracts for April[1]

AUTHOR	PAGE
Ackermann, H. and Scheidhauer and Giessing Akt.-Ges.	234
Agde, G.	249
Aleksandrov, I.	216
Andreasen, A. H. M.	246
Arndt, H.	225
Austin, A. O.	244
Avery, C. L.	204
Azbe, V. J.	212
Babille, M.	224
Barab, J.	263
Barth, H.	251
Barton, D. C.	253
Bates, P. H.	215
Baumhauer, F.	238
Berdel, E.	263
Berger, E.	222
Berry, E. R.	238
Blunt, R. A.	248
Booth, C.	203
Boyd, W. H.	238
British Hartford-Fairmont Syndicate, Ltd. and Wardley, T.	229
British Thomson-Houston Co., Ltd.	204
British Timken, Ltd. and Loader, F.	203
Brownlee, W. K.	238
Burton, J.	249
Butcher, C. H.	245
Bulter, J. A. V.	259
Cantor, T.	219
Capart, J.	209
Capra, A. M.	247
Carborundum Co., Ltd.	239
Carpenter, A. H. and Huntley, P. C.	209
Carpmael, W.	239
Carter, F. E.	253
Castelli, G.	260
Chapman, and Mott.	249
Clemens, E. F.	230
Cluett, C.	245
Coale, C. H.	230
Cooke, R. D.	217
Coons, A. T.	254
Corning Glass Works	229
Cramer, F.	242
Cronshaw, C. J. T.	263
Cross, W. and Shannon, E. V.	255
Currie, J.	225
Czerny, R.	249
Damour, E. and Thuret, A.	224
Davey, W. P.	217
Deutsche Gasglühlicht-Auer-Ges.	239
Devaux, H. and Aubel, E.	259
Dienes, W. G.	249
Director of Building Research	241
Dorfner, J.	248
Draffin, J. O.	214
Dulac, A.	219
Dunn, A. E. V.	232
Eckert, F.	220
Eitel, W.	258
Ernst, E. S., W. S., and W. S.	211
Evans, A. E.	246
Faber, A.	250
Farish, W. A.	238
Feddersen, M.	204
Firth, C. and W. N.	206
Fischer, H.	221
Fiske, G. M.	233
Forbes, C. R.	234
Forbes, W. A.	218, 238, 248
Franke, A and Dworzak, R.	260
Funk, W.	208
Furness, J. W.	254
Gallasch, G.	227
Gardner, E. D. and Howell, S. P.	263
Gardner, R. D.	203
Garve, T. W.	232
Gehlhoff, G.	220
Gehrig, O.	208
George, R. D.	255
Gibson, K. S. and Kraus, F. K.	223
Giles, A. W.	255
Goddard, W. T.	244
Goldschmidt, V. M.	255
Gourdjian, W. and Jones, G. L.	244
Green, A. T.	234, 236
Gregg, B. L.	230
Greiner, W.	204
Guillissen, J.	259
Guillissen, J. and Richard	259
Gumz, W.	263
Gwosdz, J.	249
Haalck, H.	253
Haddan, A. J.	261
Haddan, R.	239
Hancock, S.	244
Hanley, W. L., Jr.	252
Hansen, W. C., Brownmiller, L. T., and Bogue, R. H.	256
Hartford-Empire Co.	239
Haslam, R. T. and Smith, V. C.	213
von Heider, H.	242
Heinrichs, H.	260
Henry, K. M. and Burtt, P. D.	226
Herman, H.	248
Herrmann, H.	204
Herty, C. H. and Gaines, J. M.	218

[1]The abbreviation (C.A.) at the end of an abstract indicates that it was obtained from Chemical Abstracts by coöperative agreement.

AUTHOR	PAGE
Hidnert, P. and Sweeney, W. T.	258
Hill, J. M.	254
Hodecker, W.	227
Hudson, R. P.	259
Huestis, T. B.	230
Hyten, C. D.	209
Illig, K.	221
Jacob, K.	242
Jacobus, D. S.	216
Jaeckel, G.	224
Jakkula, A. A.	215
Joseph, A. F.	256
Jürgel, P.	264
Kappen, H. and Rung, F.	260
Kästner, F.	258
Killias, E. and H.	240
Killig, F.	216
Kinzie, C. J.	238
Klinski, E. A.	253
Knoblauch, H.	220
Kroye, F.	218
Kühl, H.	219
Kumagae, K. and Yoshioka, T.	209
Kutchka, K. G.	226
Lamort, J.	237, 248
de Lapparent, J.	253
Lecrenier, A. and Gilard	226
Liesigang, R. E.	258
Lloyd, W. F.	258
Loo, W. W. and Kern, E. F.	255
Lorenz, E. H.	226
Lundell, G. E. F. and Knowles, H. B.	219
Mackenzie, D. G.	233
Marshall, J.	206
Marshall, W.	217
Martin, R.	250
Mauder, B.	208
Maxwell, G. B., Payman, W., and Wheeler, R. V.	251
McCormick, J. A. and Cabell, C. A.	216
McVay, T. N.	212
McVay, T. N. and Breen, J. P.	245
Meess, H.	219
Meyer, A.	259
Meyer, J. and Pukall, K.	263
Middleton, J.	254
Miller, W. J.	244
Minter, M. M.	247
Moorshead, T. C.	230
Mott	237
Murawleff, L. N. and Grigorjew, P. O.	218
Murray, B. L.	261
Murray, J. A.	212
Murray, J. A. and Foster, H. D.	232
Naamlooze Vennootschap etc.,	229
Nevaux, V.	242
Nold, H. E.	230
Noyes, A. A. and Bray, W. C.	261
O'Breen, O.	263
Orthaus	213
Otstot, E. D.	230
Owen, W.	226
Pahl, A.	247
Parmelee, C. W. and Westman, A. E. R.	235
Patent Treuhand Ges.	229
Paul, C. H.	246
Peiler, K. E.	226
Pelka, O.	208
Peters, O. S.	258
Phelps, R. G. and Staudenmeir, L.	228
Pijoan, J.	209
Pipkin, M.	228
Platzmann, C. R.	211
Polk, G. C.	245
Pommer, O.	249
Prantner	263
Preston, F. W.	220
Pukall, W.	240
Purdy, R. C. and MacGee, A. E.	201
Ramsay, J. D.	236
Ramsbury, C. J.	236
Rankin, C. H. and Rankin Automatic Glass Feeder Co., Ltd.	230
Rengade	215
Rhenania Kunheim Verein Chemischer Fabriken Akt-Ges.	240
Rieke, R.	242
Rieke, R. and Guilleaume, A.	201
Riepert	216
Santmyers, R. M. and Middleton, J.	254
Schaller, W. T.	237, 253
Schauer, T.	218
Scheffel, W.	217
Scheidhauer & Giessing Akt-Ges.	238
Schmidt, R.	219
Schnurpfeil, H.	219
Schollenberger, C. J.	259
Schulz, H.	217, 220
Schutz, H. R.	227
Searle, A. B.	230
Setterberg, I.	239
Sherman, R. A.	235
Siegfus, S. S.	237
Siegheim, F.	227
Simon, J.	249
Smith, C. O. and Booth, C.	203
Smith, H. L.	225
Soc. Anon des Manufactures des Glaces etc.	229
Spencer, L. J.	254
Spooner, W. B.	245
Springer, L.	208
Springorum, E.	263
Steger, W.	234
Stern, B.	264
Stimson, J. C.	228
St. John, J. L.	244
Stockbarger, D. C.	260
Stoddard, B. H.	254
Stout, L. E. and Whitaker, G. C.	255
Strache, H. and Ulmann, H.	251
Straight, H. R.	233
Strack, O. and Pfälzische Chamotte u. Thonwaren A.-G.	239
Strunk, E.	239
Sugie, S.	225
Sullivan, J. D.	257
Suzuki, T.	234
Sylvany, R.	249
Tabata, K.	220
Teller, S. J.	203
Theobald, E. F.	230
Thiene, H.	224
Thoenen, J. R.	237
Tilley, C. E.	254
Tippmann, O.	247
Turner, W. E. S.	206
Van Brunt, J.	247
Van Nieuwenburg	258
Varley, T.	257
Veach, C. W.	236
Velten, H.	246
Vielhaber, L.	217
Vondracek, R.	248
Von Friedrich	206
W. H.	208
Waggnof, H.	207
Walls, N. S. and Wheeler, R. V.	251
Wayringer, H. A.	227
Webster, H.	252
Weigel, W. M.	254
Wendler, A.	220, 222
Weymouth, L. E.	215
Whiteley, J. T.	264
Wildhaber, E.	203
Willhofft, F. O.	245
Williams, M. L.	203
Winchell, A. N.	252, 255
Wobbe, G.	251
Wolf, J.	258
Yamazawa, I.	210
Zimmerman, K.	208
Zschimmer, E.	220

Abrasives

Some physical properties of artificial aluminous abrasives. Ross C. Purdy and A. Ernest MacGee. *Jour. Amer. Ceram. Soc.*, **11** [3], 192–203 (1928).—Specimens representing six different bond compositions in soft, medium, and hard grades of artificial aluminous grinding wheels were tested for various physical properties such as hardness, elasticity, expansion, mechanical endurance, impact strength, etc. It was found that the expansion of present commercial grinding wheels and abrasive bonds is much less than that of artificial corundum. The strength of the wheels increases greatly with increasing percentages of bond. The methods of making the various physical determinations are given along with their interpretation.

Character and properties of ceramic bonds for grinding agents and hardness test for grinding wheels. R. Rieke and A. Guilleaume. *Ber. deut. keram. Ges.*, **8** [5], 258–76 (1927).—The following three systems of ceramic bonds for grinding wheels were investigated principally with regard to the hardness of the bond obtained: (1) clay substance-feldspar-quartz, (2) clay substance-feldspar+4% $CaCO_3$+2% $MgCO_3$-quartz, (3) clay substance-feldspar+8% $CaCO_3$+4% $MgCO_3$-quartz. The two methods used in expressing the hardness of the wheels are: (1) the Norton scale, and (2) the depth of the cavity produced by a sand blast. The sand-blast test was carried out on a Mackensen apparatus which forces a definite amount of sand of definite grain size under a definite air pressure through a standard nozzle onto the test piece. The depth of the cavity produced is measured by means of a dial mounted on the instrument.

Table I. Composition of Bonds Tested

Bond No.	Marble	Magnesite	Quartz	Feldspar	Zettlitz kaolin	Bond No.	Marble	Magnesite	Quartz	Feldspar	Zettlitz kaolin
1				100		39	4	2		29	65
4				65	35	41	4	2	10	29	55
7				50	50	43	4	2	20	39	35
10				35	65	44	4	2	20	29	45
12			10	55	35	46	4	2	20	14	60
14			10	35	55	47	4	2	30	39	25
18			20	35	45	49	8	4		38	30
20			20	20	60	51	8	4		23	65
21			30	45	25	53	8	4	10	23	55
23			30	25	45	55	8	4	20	33	35
37	4	2		44	50	56	8	4	20	23	45
						58	8	4	20	8	60
						59	8	4	30	33	25

The instrument and method are described in detail. The bodies were fired to cones 8, 10, 12, and 14. The amount of bond used was 20, 25, and 30%. For the preparation of the bond the most plastic clay should be taken since the plasticity of the kaolins does not suffice especially in the casting process to produce a solid cohesion of the body in the dried condition. Further a feldspar or a feldspar-rich rock should be used. Additional flux of various kinds may be introduced into the bond. The flux can be used in the pure form or introduced as a clay with considerable fluxing material present (slip clay). At the same time the addition of this type of clay introduces a certain amount of quartz. The amount of these materials (flux and quartz) to be used in the bond is determined by the firing temperature of the body. The amount of clay substance present in the bond varies between 40–60%. The amount of feldspar is not as high; it is shown by this investigation that a very high feldspar bond has unfavorable mechanical properties. The feldspar content should not exceed 40%. The quartz improved the mechanical properties of the body but on the other hand in the higher percentages it decreased the plasticity of the bond and affected the type of structure of the body. The quartz content should be 10–20% of the bond. The amount of additional flux such as $CaCO_3$ and $MgCO_3$ determines the hardness of the body and the firing temperature and should be 5–15% of the bond. The firing temperature of the grinding wheel must lie above the

sintering temperatures of the bond and for hard bodies above the cone fusion point of the bond. The sand-blast method of determining hardness seems to be suitable for the hardness test of grinding wheels. The conditions of the test are determined by the size of the sand grains, the air pressure, and the dimensions of the air nozzle. For testing of wheels of various grain size it is necessary to set up a special table for every grain size with various gradations in hardness. Large wheels must be blasted with sand of large grains and small wheels with sand of small grains in order to obtain favorable test conditions.

TABLE II. HARDNESS (SCRAPE TEST) OF BODIES

Bond No.	Firing temperatures: Cone 8, Per cent bond			Cone 10, Per cent bond			Cone 12, Per cent bond			Cone 14, Per cent bond		
	20	25	30	20	25	30	20	25	30	20	25	30
1	O–P	P	P	P–Q	P–Q	P–Q	††	††	††	—	—	—
4	I–J	J	K	M	N	O	O	P	P	—	—	—
7	—	—	—	—	—	—	J	K	L	N	O	O–P
10	—	—	—	—	—	—	H–I	I	I	J	K	K–L
12	—	—	—	J	J–K	K	N	O	O–P	P–Q	††	††
14	—	—	—	—	—	—	I	I–J	J	J	K	I–J
18	—	—	—	—	—	—	I–K	K–I	—	L	L–M	M
20	—	—	—	—	—	—	—	—	—	I–J	J	I–J
21	—	—	—	—	—	—	N–O	O–P	P	P–Q	††	††
23	—	—	—	—	—	—	—	—	—	—	J	J–K
37	G–H	H	I	I	I–J	J	L	M	N–O	—	—	—
39	—	—	—	—	—	—	H	I	I	J–K	L	L
41	—	—	—	—	—	—	I	I	I–K	L	L–M	M
43	H–I	I–J	J	J	K	L	P	P	P	—	—	—
44	—	—	—	—	—	—	J	K	L	O	O–P	P–Q
46	—	—	—	—	—	—	H	H	H–I	I	K	K–L
47	O	O	O–P	O–P	P	Q	—	—	—	—	—	—
49	H	H	I	K	K	K–L	N–O	O	O	—	—	—
51	—	—	—	—	—	—	H	I	I	M	N	N–O
53	G	G–H	G–H	H	H–I	I	I	I–J	I–J	—	—	—
55	J	L	M	O	P	P–Q	—	—	—	—	—	—
56	G–H	H	H	I	J	J	M–N	N	N–O	—	—	—
58	—	—	—	†	†	†	G	G	G–H	M	N	N–O
59	N	P	††	††	††	††	—	—	—	—	—	—

The above letters refer to the Norton scale (F,G,H,I,J,K, soft bodies; L,M,N, medium hard bodies: O,P,Q,R, hard bodies).

† Body so soft that apparatus did not indicate

†† Body so hard that measurements were inaccurate

TABLE III. DEPTH OF PENETRATION PRODUCED BY THE SAND BLAST ON THE VARIOUS BODIES

Bond No.	Firing temperatures: Cone 8, Per cent bond			Cone 10, Per cent bond			Cone 12, Per cent bond		
	20	25	30	20	25	30	20	25	30
1	1.02	—	1.76	0.91	1.59	1.65	0.82	0.84	0.91
4	—	2.79	2.36	1.93	1.95	—	0.94	0.91	0.97
7	—	—	—	—	—	—	—	2.00	—
10	—	—	—	—	—	—	—	3.01	2.95
12	—	—	—	—	2.22	2.51	—	1.44	—
14	—	—	—	—	—	—	—	2.20	2.43
37	5.54	3.78	3.44	3.34	2.86	2.73	1.80	1.67	1.06
39	—	—	—	—	—	—	—	3.82	3.40
41	—	—	—	—	—	—	3.17	3.37	2.80
43	—	3.00	—	2.79	1.99	1.82	0.96	1.20	1.22
44	—	—	—	—	—	—	1.85	2.40	2.05
46	—	—	—	—	—	—	3.52	3.95	4.08
47	1.17	1.55	1.28	—	0.85	0.69	—	—	—
49	3.90	3.86	3.17	1.81	2.13	1.99	0.92	—	1.00
51	—	—	—	—	—	—	—	3.95	4.04
53	6.50	5.53	5.93	3.96	3.61	—	—	3.48	3.82
55	2.75	2.30	—	—	0.76	—	—	—	—
56	—	4.68	5.23	2.89	2.57	2.63	—	—	1.47
58	—	—	—	—	4.41	4.07	5.76	5.45	5.03
59	1.47	0.92	0.86	—	0.44	0.36	—	—	—

F.P.H.

Abrasive materials in 1926. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 245–53.—Natural abrasives are discussed with one paragraph on artificial abrasives. The natural abrasives included are millstones, grindstones and pulpstones, oilstones

and scythestones, corundum and emery, garnet, tripoli, diatomite, pumice, pebbles for grinding and flint lining tube mills. Imports and exports and world production are given. R.A.H.

PATENTS

Ring-grinding machine. RALPH D. GARDNER. U. S. 1,659,092, Feb. 14, 1928. In a grinding machine having a rotatable grinding wheel presenting a grinding face, a work supporting bar extending across a portion of the face, a work retaining member positioned above the bar, said member being supported to yield upwardly when work is received between it and the bar, and means for varying the minimum distance between the bar and member.

Centerless grinding. CLAYTON O. SMITH AND CLEMENT BOOTH. U. S. 1,659,220, Feb. 14, 1928. In combination with a centerless grinder embodying opposed grinding and regulating wheels and an intermediate work-support, a work-holding fixture having a cylindrical portion for coöperation with the work-support and regulating wheel, and having a work-receiving socket concentric with the periphery thereof, and means on the work-support for urging the cylindrical portion of the work-holding fixture in the direction of the regulating wheel.

Bevel gear grinder. SPENCER JAY TELLER. U. S. 1,659,224, Feb. 14, 1928. A bevel gear grinder comprising in combination, a base, a support thereon, a wheel adjustable on the support, means to rotatably support a blank to be ground, means to revolve the blank bodily in an orbital path, and means to simultaneously rotate the blank upon its axis, the rotary and revolving movements being incommensurate with each other whereby the blank will be angularly advanced at the completion of each revolving movement.

Grinding helicoidal surfaces. ERNEST WILDHABER. U. S. 1,659,227, Feb. 14, 1928. The method of grinding an involute helicoidal surface on a blank, which consists in providing a grinding wheel having a flat grinding surface, in effecting an angular adjustment and 2 rectilinear adjustments between the wheel and the blank so that the shortest connecting line between the axis of the blank and the axis of the wheel is outside the surface of the grinding wheel, and in rotating the wheel and the blank while effecting relative feeding movement in accordance with the pitch of the helicoid.

Vertical grinding machine. MARTIN L. WILLIAMS. U. S. 1,659,228, Feb. 14, 1928. In a vertical grinding machine, the combination with spaced supporting columns having a central opening, of a head mounted on one side of the opening, a connection passing through the opening communicating between the head and a source of driving power, a grinding spindle mounted on the head and adapted to be rotated by the source of power, a rotating table on which the work is mounted, a support for the table, a motor mounted on the table support for rotating the table, and means for tilting the table and table support to a desired angle from the horizontal.

Grinding. CLEMENT BOOTH. U. S. 1,659,237, Feb. 14, 1928. The combination with a centerless grinder including opposed grinding and regulating wheels forming a work-receiving throat therebetween, of a work support having a portion disposed within the throat and a portion exterior thereto, laterally adjustable guide members adjacent to work support forming therewith a work-receiving trough, and means movably supported by the workrest and depending within the trough for applying longitudinal pressure to work-piece when within the throat.

Centerless grinding machines. BRITISH TIMKEN, LTD., AND F. LOADER. Brit. 280,446, Dec. 31, 1927. In a centerless grinding machine for grinding cylindrical, tapered, and shouldered bodies, the work pieces are fed to apertures in the periphery of a magazine wheel, which is rotated intermittently to position the pieces for grinding

between the opposed peripheries of the grinding and control wheels, and upon a subsequent rotation to discharge the ground pieces.

Abrasive compositions. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 281,711, Feb. 1, 1928. Grinding-wheels, whetstones, sand paper, etc., are made by mixing an abrasive such as alundum, Carborundum, emery, garnet, with a polybasic acid, polyhydric alcohol condensation product. A plasticizing agent such as indene polymer, tricresyl phosphate, glycol diacetate, diethyl phthalate, benzyl benzoate, triacetin, cumar resin, ester gum, pitch, diphenyl, or a natural gum may be added. The resin may be dissolved or powdered for admixture with the abrasive, or a surface may be coated with a solution, and the grains of abrasive applied when tacky, and the whole baked. A mixture may be molded at 150°C, cooled to 75°C, removed from the mold, and cured by heating without pressure for 50–150 hours at a temperature rising from 75°C to 190°C.

Art

The production of decorations on enameled ware. W. GREINER. *Keram. Rund.* **35,** 805–806 (1927).—Lithography, painting, spraying over stencils, and stamping as methods of decorating and the suitability of such methods for quantity production are briefly discussed. Two sample cost sheets giving the cost of producing and decorating 1000 enameled cups and plates are shown. H.I.

Some unusual methods of decoration used in Chinese ceramics. MARTIN FEDDERSEN. *Keram. Rund.*, **35,** 829–32 (1927).—The article is illustrated by photographs of pieces in the Hamburg Museum of Arts and Trades. H.I.

Modern problems in ceramic art. HANS HERRMANN. *Keram. Rund.*, **35,** 847-48 (1927). H.I.

German and Dutch glass from the Mühsam collection. C. LOUISE AVERY. *Bull. Met. Mus. Art*, **23** [1], 3–15 (1928).—Some 400 rare and fragile pieces of glass compose the recent important additions to the Museum's collection. They represent half of the collection formed by Jacques Mühsam of Berlin, the other half having been acquired by the Art Institute of Chicago. Jacques Mühsam began collecting 30 years ago, eventually securing fine examples of practically every type of Dutch, German, and Bohemian glass, including the medieval Waldglas, the enameled ware of the Renaissance, forms directly inspired by Venetian models, the various styles of engraved and gold glass of the 17th and 18th Centuries, and, finally, the "Biedermeier" productions of the 1815–1845 period. Robert Schmidt, now Director of the Kunstgewerbe Museum (Schloss), Berlin, is quoted as saying the collection of Mr. Mühsam is superior to all the important collections on the Continent and in England, not only in numbers but in quality. Even the Museum collections at Berlin, Vienna, and London, are surpassed by it in nearly every respect. In two volumes Schmidt describes the collection, each piece in detail, and also gives admirable summaries of the various styles. Some analyses of important types are given here, to give prominence to most significant pieces and to indicate the merit and comprehensiveness of the new accessions. The greenish color of the Waldglas came from uncontrolled iron in the composition of the glass. The variations in tone are very pleasing. Two tiny bottles excavated near Cologne, belonging to the late medieval period, demonstrate the relationship to the old Roman glass. An interesting series of glasses shows development of forms through the 15th and 16th Centuries. These types were often pictured by artists of the Low Countries, especially by Dirk Bouts, and later by Dürer, Holbein, and the Nuremburg Little Masters. While some medieval German glass-makers knew the formulas for Venetian glass, they did not have the necessary ingredients, so their Waldglas developed independently. But increasing intercourse between Italy and Germany resulted in

exchange of styles in glass. By the end of the 13th Century, Venice was on the way to supremacy in glass making and well into the 17th Century she exerted a powerful influence upon the glass of Europe. Venice herself sometimes borrowed designs. One of the most impressive pieces among the Mühsam acquisitions is a large boldly formed pokal made in Venice about 1500. It is an adaptation of shapes of silver work imported from Western Europe. They also developed the use of gilding and of enamel in imitation of highly prized wares from Syria. The deep blue glass ornamented with bright-colored enamels from Venice was imported into Germany in the 16th Century and soon the German glass makers began to develop the new technique. After the 17th Century it declined in favor as the new vogue was created by the discovery of crystal glass and new methods of engraving it. The enameled decoration was put on forms definitely German. Drinking bouts were very popular and these enameled glasses were used for this purpose. Some were ornamented with coats of arms. The Museum has also acquired a splendid example of Reichadlershumpen dated 1587, displaying the double-headed eagle of the Holy Roman Empire. The range of the opaque enamel colors is limited, as they were fired in the cooling furnace, but their merit lies preëminently in their general decorative effect. Designs were largely drawn from wood cuts and engravings. Among other examples an interesting group comprises a tray and twelve cordial glasses painted with animated little figures, jesters, old wives, harvesters, and fine ladies in costumes of 17th Century. The German glass makers not only borrowed from Venice the technique of enamel painting for their native glass, but also copied Venetian glass of another sort. Creditable imitations of the dainty, clear, Venetian glass were made first at Antwerp, and the other towns in the Low Countries followed. So clever were these imitations that it is yet impossible to determine in some cases whether a piece was made in Venice, in the rival Italian town of Altare, in the Netherlands, or Germany. Engraving with a diamond point was also inspired by Venetian models from the late 16th Century on. Copying the colorless glass of the Venetians, the German craftsmen succeeded in producing a glass completely colorless, perfectly fitted for brilliant engraving, likewise discovered by German craftsmen. Kaiser Rudolf II attracted many Italian and German artists to his court at Prague. Caspar Lehmann first engraved glass. A covered beaker, 1592, now the property of the Museum, is believed to be his work and is the earliest dated example known. The form is distinctive and the decoration elaborate. It was given as a bridal gift, celebrating the marriage which united the great houses of Schwartzburg and Braunschweig-Lüneburg. Lehmann enjoyed the privilege of being "imperial precious stone and glass cutter" to Rudolf II and passed on the distinction to Georg Schwanhardt, his pupil, who after Lehmann's death established the art of glass cutting at Nuremberg. The work at Nuremberg is represented by a series of baluster goblets and beakers from 1665 on and includes examples by two of the chief artists, Schwinger and Killinger. The alchemist, Johann Kunckel of Pottsdam, whose researches led to the manufacture of a rich ruby glass, was the great man in Brandenburg glass making. The collection includes 59 examples of the various gold glasses made in Bohemia from 1710 to 1760. Gold glass was in disfavor about the middle of the 18th Century but Johann Mildner of Guttenbrunn in Austria revived the technique about 1785. Dutch examples of glass engraved with a diamond point are well represented in this collection. Out of this style developed the stippling with a diamond point, which remained an art peculiar to Holland. Frans Greenwood was the greatest master of this technique, and of the ten known examples of his work the greatest is represented here. The illustrations give a very good idea of the range of the collection. A.A.A.

Brick with the beauty fired in. ANON. *Clay-Worker*, **89** [2], 120–23 (1928).—A little of the history of the Stephenson Brick Co., of Birmingham, Ala., one of the

leading southern face brick manufacturing concerns. Their brick are known as "Cordovas," "Venetians," "Orientals," and "Harvards" according to the color, texture, etc. The Cordova, Ala., plant of this company, which cost approximately $450,000, is described. E.J.V.

Alabaster, black, and colored glass in interior decoration. VON FRIEDRICH. *Diamant*, **49** [13], 243–45 (1927).—An exhibit at the Leipzig Fair is described. It consisted of a wash-basin of alabaster glass with nickel feet, standing on a flooring of alabaster and black glass plates which had the appearance of a marble floor. The tendency and opportunities for the use of glass as a material for interior decoration were indicated by the exhibit. Descriptions of a fire-place and a bookcase built of glass are given. For cleanliness and durability, polished glass is recommended for use in laboratories, operating-rooms, hospitals, bathrooms, barbershops, confectioneries, and for tables in kitchens and restaurants. E.J.V.

Modern artistic glassware. W. E. S. TURNER. *Pottery Gaz.*, **53** [607], 104–10 (1928).—The brilliance, transparency, color, light-transmitting qualities, and other properties of glass are discussed. In utilization of glass for artistic purposes two essential principles which have to be kept in mind if the result of the manipulation is to achieve a standard of artistic permanence are (1) a true conception of form, and (2) an understanding of the nature, properties, and possibilities of the material itself. The question of form has not received much attention and not much progress has been made in this direction since the development of the later Egyptian glass or some of the Roman and Venetian glasses, whose elegant form deserves to be remembered. The best results in decoration were achieved when the special properties or qualities of the glass were considered. Developments in the production of artistic glassware are taken up under several different heads: (1) American glassware: the "pressed-cut" type, "Tiffany Ware," and Frederick Carter's productions; (2) Scottish glassware: the Perth glass works; (3) Continental glassware: grouping Germany, Czechoslovakia, and Austria, where the range of utilization of different methods for the art there developed is wide and everything seemed to be attempted from cutting and engraving to decorating with enamels; (4) Swedish glassware: the Orrefors Works; and (5) French glassware: the most noteworthy successes are centered round the strong personalities of individual artists, including Rousseau, Gallé, Lalique, Despret, and Marinot. A discussion follows. E.J.V.

Blue-tiled tomb at Sakkara. C. AND W. N. FIRTH. *Illust. London News*, **172**, 8–9 (1928).—A full-page colored illustration of a doorway in the tomb of Pharaoh Zoser, 3000 B.C., discovered by F., who is director of the Egyptian Antiquities Dept. excavations at Sakkara (see *Ceram. Abs.*, **7** [2], 65 (1928)). The walls are tiled, giving the impression of being lined with reed mats, the tile being let into grooves in the stone, while narrow bands of white limestone are carved to represent the fastenings by which the reeds are held together. There are also 5 photographs of the architecture of the tomb, some of it looking strangely non-Egyptian and even ultra-modern. H.H.S.

Prehistoric civilization of the Indus. JOHN MARSHALL. *Illust. London News*, **172**, 12–15 (1928).—Eighteen photographs of the recent archaeological discoveries in the Indus Valley and the Punjab by M., who is director-general of archaeology in India. Among the finds are a finely modeled bull in terra cotta and a mastifflike dog in faience. A feature of the discoveries was the drainage on modern lines of towns dating from 3300 B.C. and showing amenities of life far in advance of anything found of that time in Babylonia or on the banks of the Nile. H.H.S.

Belgian pottery 3000 years old. ANON. *Morning Post*, Jan. 5, 1928.—A pottery factory thought to be of the Iron Age has been discovered among the dunes at LaPanne by the research department of the Royal Cinquantenaire Museum. Vases and tripods

were found, the vases bearing at the bottom the imprint of the tripods, from which fact it is thought that the pottery was dried on the tripods before firing. The method of firing was to put thick rods of earthenware in holes arranged in flat plates of fired clay, and on the stand thus formed to place the dried ware. This stand is the first of its kind to be known. The discoveries include thousands of fragments of pottery, as well as the clay deposits used by the potters. It is thought that the factory was in full operation for at least 1000 years. H.H.S.

Novel pottery decoration. ANON. *Ceram. Ind.*, **10** [2], 164 (1928).—Coloring matter on pottery ware, such as the oxide of a metal, preferably in powder form, is mixed with a mat medium, composed of about 5 parts quartz, 1 part lime, and 1 part clay, also in powder form. Liquid gum, or other viscous substance, is added, and the whole mixture worked up into a paste of viscous fluid. The proportions of mat medium and coloring agent vary according to the strength of the latter. The design is transferred or pointed with this mixture on ware which has been dipped in glaze but not fired. The design is then fired on, and the result is an unglazed design upon a glazed ground, both effects being produced in a single firing process. F.P.H.

Iridescent colors on glassware and pottery. HENZEL WAGGNOF. *Ceram. Ind.*, **10** [2], 190–92 (1928).—Formulas for the various lusters of colors on ceramic ware and their methods of application are given. The following types are discussed: (1) high luster glazes, (2) resinate lusters, (3) cold lusters, (4) pressed glass lusters. Luster-glazes, obtained by the effect of vapor-smoke on the red-hot surface, are designated as metallic reduction or high-heat lusters. They may be obtained in one firing by permitting the temperature, after the glaze has run smooth, to drop a few cones (from 660–800°C) and by following this with a sharper reduction in temperature. It is, however, more advantageous to obtain the luster by a second firing in a muffle-kiln at dark to light red-heat temperature below the melting point of the glaze. To make reduction by firing most efficient, vaporizing materials, such as tar, naphthalene, oil, petroleum-saturated sawdust, etc., are introduced into the muffle through the peephole as soon as firing has ended. Then the slide is again fastened and all openings sealed. This procedure is repeated according to the extent of the kiln area. For a cubic meter muffle, in a reducing temperature of cone 015, 4 or 5 such treatments with 250 to 300 g. naphthalene are applied at intervals of half an hour. In the case of a muffle of half that size and at cone 017, 3 such applications at intervals of half an hour suffice. For iridescent lusters of a golden tone the following compositions may serve: copper sulphate 10 parts, ferrous sulphate 5 parts, silver sulphide 1 part, yellow and red ocher 12 parts, copper sulphate 5 parts, nitrate of silver 2 parts, oxide of iron 1 part, Armenian umber 4 parts. Another method of producing luster is based on the evaporation of the metallic fusibles by spraying a chloride or nitrate solution on the glowing ware after it has been fired smooth. The solvent evaporates while the metal salts form a tender skin. The ware is then refired in the muffle kiln. Brief mention must also be made of the so-called cold lusters which are much used on porcelain and glass. For this purpose a gelatin paste is prepared by a water-soaking process and subsequent warming. The gelatin is mixed with a thin paste of oxide of zinc, white lead, chalk, and barium. Glass or porcelain are covered with this mix and then immersed in a bath consisting of 1 part of nitrocellulose, 75 parts 95% alcohol, 20 parts ether and water. Following this bath which should take place in a receptacle with small surface area, the ware will be covered with a thin skin, and this, following drying, will show iridescence. According to Parkert, addition of benzine to the bath will promote iridescence, and if benzine is used, the place of nitrocellulose may be taken by potassium silicate in a ratio of 10 parts to 90 parts of water. A frequently occurring shortcoming, that of peeling of the iridescent luster, is briefly considered. Often the cause is poor cleaning of the ware.

Quite frequently a fatty sort of film adheres to glass surfaces. It is best removed by washing in warm, acidulous water and applying whiting; the ware is then rinsed off in clean water and dried. Another source of trouble may be the luster colors, especially if the oils and rosin used were impure. Too thin oil or too hot a muffle may cause the luster colors to bubble. If there is too much rosin in the mixes, uneven expansion may cause some parts of the luster to chip or peel. F.P.H.

Secrets of eight Chinese and Saxon porcelains. ANON. *Keramos*, **6** [9], 337–40 (1927).—The secrets are divulged by their owner, Johann Andreas Rudiger, Berlin, 1750. F.P.H.

Red uranium glazes and chrome red crystal glazes. K. ZIMMERMAN. *Sprechsaal*, **60** [47], 871–72 (1927).—A synopsis of two articles by Z. which appeared in the *Klei* journal (Holland). Preparation and discussion of uranium and chrome red glazes are given. R.A.H.

History of ceramic ware decoration. W. FUNK. *Sprechsaal*, **60** [52], 999–1002 (1927).—A review of old and new methods of decorating pottery for 60 years. R.A.H.

History of ceramic art. OTTO PELKA. *Sprechsaal*, **60** [52], 1002–1005 (1927).—A review of ceramic art during the last sixty years. R.A.H.

History of glass decoration. L. SPRINGER. *Sprechsaal*, **60** [52], 1042-44 (1927).—Cut and engraved glass, sand blasting, etching, and other forms of decorating glassware for the past 60 years are reviewed. R.A.H.

Development in shapes (molds) in the glass industry. BRUNO MAUDER. *Sprechsaal*, **60** [52], 1044–46 (1927).—Sixty years of development in the glass industry are outlined. R.A.H.

German mosaic and the German glass painting art. OSCAR GEHRIG. *Sprechsaal*, **60** [52], 1046–48 (1927). R.A.H.

"Mars yellow," basic iron oxide pigment. ANON. *Farben-Ztg.*, **32**, 1435–37 (1927).—The analysis of the pigment gives on the average for Fe compounds 51–53, CaO 23–24, CO_2 (from $CaCO_3$) 18–18.5, H_2O 3.5–4%. The orange-yellow product is made from $FeCl_2$ and $CaCO_3$ and contains an excess of $CaCO_3$. The pale yellow pigment is formed by the action of $CaCO_3$ on $FeSO_4$. The resulting $CaSO_4$ remains partly with the pigment. Oxidation increases the brilliancy of the pigment. (*C. A.*)

The cutting of indentations in glass and glass stoppers. ANON. *Glas und Apparat.* **8**, 94 (1927).—A description of a machine (the Feilkopf) and its operation, for cutting divisions, spiral grooves, and generally ornamenting glass articles. (*J.S.G.T.*)

The coloring of finished glass. W. H. *Allgem. Glas. und Keram. Indust.*, **18** [6], 6 (1927).—When the finished ware is coated with a solution of 6 g. of gelatin and 1 g. of silver nitrate per 100 g. of water, dried in the dark, and then exposed to light for a time, a yellow or red coloration is obtained. With 2 g. of silver nitrate, a dark yellow, and with 4 g. a dark red to reddish-brown tint is obtained. The strongest solution, when dried onto the glass for 8 days in the dark, washed, and exposed to light while moist, gives the effect of an incomplete metallic mirror. Multicolored designs are produced by coating the glass surface with copal varnish in turpentine, to which the coloring leaves are pressed without drying. To obtain special effects the glass is covered with a colored emulsion of a metallic salt (*i.e.*, 120 cc. of 18% gelatin solution, 48 cc. of 6% ammonium bromide, 24 cc. of 10% potassium bromide, and 48 cc. of 10% silver nitrate solution with 9 cc. of ammonia), dried, and further painted with aqueous solution of a dyestuff containing sodium hyposulphite. The colored liquid penetrates the coating and, on treating with a liquid which dissolves the metallic particles, local transparent or translucent areas result. A tinting compound consists of finely-powdered aluminium with boiled gelatin as a bond and a dyestuff as tinting medium. For lamp bulbs, a

collodion solution colored by fluorescein serves as coloring agent. Faiencelike effects result when the back of a glass plate is coated with water-glass and sprinkled with dry powdered dye. After drying, a ground-color coating is given and the whole varnished. As a protective layer for decorations of the above type, a coating of asphalt varnish is used, over which is poured a mixture of asphalt, red lead, and ocher. For color printing, a coating of viscous varnish-mixed lac or transparent color from the lithographic stone is pressed onto transparent paper and this rubbed onto the glass until the color holds. After moistening the back of the paper, rubbing is continued until the design is transferred. When dried and washed, the surface can either be further decorated or coated with a protective layer. Ice-flower effects result when a concentrated aqueous solution of dextrin with zinc or magnesium sulphate is painted on the glass evenly and thinly and the glass laid horizontally to allow of free evaporation of the water. A suitable protection for such a design consists of a coating of alcoholic shellac. (*J.S.G.T.*)

BOOKS

Egyptian Art: Documents pour servir à l'étude de l'Art Egyptien. JEAN CAPART. London: The Pegasus Press, 1928. Price, edition *de luxe* 15 guineas; half-leather 7 guineas. Folio, 90 pp. of text, 100 collotype plates. Limited to 600 numbered copies. H.H.S.

History of Art. JOSEPH PIJOAN. Foreword by Robert B. Harshe. Translated from the Spanish by Ralph L. Roys. 3 vols. Barcelona: Salvat, 1927. Three large illustrated volumes: (1) from primitive art to the decadence of Rome, (2) from early Christian art to the origin of the Renaissance, and (3) from the Renaissance to the present day. Reviewed in *Illust. London News*, **172,** 6 (1928). H.H.S.

Imported Staffordshire Ware in Colonial Times. "Letters of a Loyalist Lady." Harvard Univ. Press, 1927.—The Loyalist Lady, Ann Hulton, whose brother was commissioner of Customs at Boston from 1768 to 1775, gives her correspondent in England, Mrs. Lightbody, the following commission: "A small crate of Staffordshire ware is to be bought at Liverpool. I sent a crate of the yellow ware from there to my brother, which cost about £3, and they are now almost demolished. My sister says if there is any new fashion or invention of Mr. Wedgwood, she would prefer it to the yellow over again, but nothing gilt, and no matter how few tureens." H.H.S.

PATENTS

Pottery. CHARLES DEAN HYTEN. U. S. 1,657,997, Jan. 31, 1928. The process of preparing a clay for the manufacture of ceramic objects which consists in reducing the clay to a consistency of cream, separately admixing and grinding a color base material, and a shrinkage-controlling material, combining the color mixture with the clay and mixing the same, extracting the excess moisture until in plastic condition, and finally rotating the plastic material and shaping an object therefrom during such rotation.

Decorated glass and method of making same. ARTHUR HOWE CARPENTER AND PHILIP C. HUNTLEY. U. S. 1,658,015, Jan. 31, 1928. A glass member having a face formed of glass cloth.

Cement, Lime, and Plaster

Hydration of cements. II. Microscopic study on the hydration of rapid hardening cements. K. KUMAGAE AND T. YOSHIOKA. *Jour. Soc. Chem. Ind. Japan*, **30** [10], 176–77B (1927).—K. and Y. studied, microscopically, the process of hydration of commercial aluminous cements and supercements of Portland type, using Keiserman and Blumenthal's staining process. In the case of aluminous cements, setting and hardening occur as the result of the formation of crystals consisting of lime and alumina,

with the retarded formation of amorphous, gelatinous mass consisting also of lime and alumina. The presence of lime hydroxide was not observed in the hydrated products. Supercements of the Portland type were found, upon hydration, to behave as in the case of ordinary Portland cements, the setting occurring as the result of the formation of crystals, and the hardening as the result of retarded impregnation and coagulation of amorphous mass among the fine net-work of crystals. Special attention was paid to the solubility of cements and crystallization of hydrated crystals out of once dissolved constituents in regard to the phenomena of setting and hardening. E.J.V.

Tests on fused Portland cement and aluminous cement. ITSUO YAMAZAWA. *Jour. Soc. Chem. Ind. Japan*, **30** [10], 177–78B (1927).—Fused Portland cement and aluminous cement was prepared in an arc type electric furnace with an electric capacity of 35 kw. The qualities of these cements were tested and compared with those of a very finely powdered Portland cement which was also tested. The results are:

	Fused Portland cement	Aluminous cement	Finely powdered Portland cement
Fineness			
Residue on 900-mesh	0.28%	0%	0%
2500 "	0.84%	1.48%	0.68%
4900 "	4.82%	3.68%	2.18%
Specific gravity	3.08	3.09	3.17
Setting time			
Initial	1 h. 9 min.	3 h. 7 min.	2 h. 14 min.
Final	2 h. 1 min.	4 h. 8 min.	3 h. 59 min.
Atmospheric temperature	25°C	23°C	21°C
Water temperature	22°C	21.5°C	20°C
Quantity of water added	26%	26.7%	25.3%
Soundness			
Normal test	Sound	Sound	Sound
Boiling test	Sound	Sound	Sound

Tensile strength kg/sq. cm. (in wet air 24 hours; thereafter in water)	Fused Portland cement		Aluminous cement		Finely powdered Portland cement	
	Neat	1:3 Mortar	Neat	1:3 Mortar	Neat	1:3 Mortar
1 day	64.5	26.8	38.8	18.0	45.8	23.3
2 "	82.5	26.5	51.3	22.4	67.1	32.8
3 "	77.0	25.3	51.5	23.0	68.0	36.3
4 "	77.3	29.5	49.8	20.0	73.1	37.3
5 "	74.8	30.0	50.8	20.5	74.0	34.2
6 "	76.5	29.0	46.3	19.8	73.8	37.0
27 "	74.8	30.0	47.0	22.9	71.2	33.8
			61.5	24.4	71.9	41.0

Chemical composition			
Ignition loss			0.76
SiO_2	22.60	10.52	22.60
Al_2O_3	6.38	41.71	5.98
Fe_2O_3	4.82	8.77	3.74
CaO	63.34	38.74	63.66
MgO	0.81	0.36	0.97
SO_3	1.88	0.88	1.82
C	3.96	5.92	0
CaC_2	0.23	1.35	0
All Fe(Fe+FeO) was determined as Fe_2O_3			
	Add gypsum when grinding	Add no gypsum when grinding	Add gypsum when grinding

E.J.V.

Efficiency of aluminum and zinc as gas-producing media in cement. C. R. PLATZMANN. *Chem.-Zeit.*, **86**, 833–35 (1927); *Rock Prod.*, **31** [1], 69 (1928).—Tests were made by P. to investigate U. S. Patent 1,087,098, which provides for admixtures of aluminum and zinc to cement, substances which in contact with water produce a strong evolution of gas, which may approach 300% by volume. The chemical reaction involved is: $2Al+3Ca(OH)_2=Ca_2(Al_2O_3)_2+3H_2$. A similar reaction takes place when zinc is added. The patent provides an admixture of .25–2.0% lime for the acceleration of the reaction. This proved unnecessary in the tests about to be described. Preliminary tests showed that the metals had to be added in a very finely powdered form and had to be thoroughly mixed with the cement before water was added. A 250-cc. cylinder was used, into which was introduced a mixture of 100 g. Portland cement, .1–.25% of which was replaced by powdered aluminum, and 50% water. The liberation of hydrogen began 10 to 20 minutes after mixing and was completed in all cases after $1^1/_2$ hours. The volume increase was but 127% in the most favorable case. To obtain results approximating practical conditions, further tests were made of cement-sand mixtures. Only a very fine sand could be used, as otherwise segregation took place. Coke cinders were also used. Admixtures of more than .25% Al were ruled out, as in such cases all of the metal did not enter the reaction nor was the volume expansion increased appreciably, the beginning of the reaction being characterized by such a violent evolution of hydrogen that the mass did not swell as it does when acted upon by small gas bubbles. Sand admixtures reduce the effect of aluminum to about 70% and the lighter coke cinders produce an expansion of 100%. Strength tests showed that the porosity resulted in a reduction of strength. The admixtures used in these tests were .1% aluminum. Compressive strength values at 28 days range from 70 kg./cm². (994 lb./in.²) for 25% sand to 7 kg./cm.² (99.4 lb./in.²) for 85% sand. An abrupt drop in strength took place beyond 40% sand. The actual strengths were somewhat higher, however, as the molds were only one-half or three-quarters filled. The specific gravity of the concrete, which may ordinarily be assumed to equal 2.0, ranged from 0.76 with no sand to 1.21 with 75% sand. Powdered zinc admixtures gave less satisfactory results, the expansion of neat cement ranging from 30–50% only. Better results were obtained when Killig's method was used, *i.e.*, adding calcium chloride to the mix. Tests of other gas-liberating substances showed a less marked effect or gave negative results. These were copper-galvanized zinc, aluminum and calcium carbide, sodium carbonate, aluminum chloride, zinc and potassium carbonate, iron chloride and calcium carbonate, magnesium superoxide and stearine. The collected test evidence disproves statements by J. Meyer and K. Pukall (*Chem. Zeit.*, p. 757 (1927)) claiming that aluminum was not a suitable agent for the production of porous concrete. F.P.H.

The new "Lombda" insulating material. ANON. *Feuerungstechnik*, **15** [24], 285 (1927).—The properties of the "Lombda" insulating material are given. The heat conductivity varies between .055 and .077 cal./mh°C over the range 50 to 400°C. Gypsum serves as the raw material and it is made into forms having very high porosity by means of a patented process. F.P.H.

Proportioning raw cement materials. EDGAR S., WALTER S., AND WILLIAM S. ERNST. *Rock Prod.*, **30** [21], 73–76 (1927).—The use of a system of triangular coördinates is compared with algebraic methods in the proportioning of raw cement materials. The triangular coördinate method is described. The purpose of this paper was to suggest a method whereby engineers and others may more quickly and accurately determine whether or not a certain group of raw materials can be combined to form a desired mixture and, if so, the approximate proportions in which they would have to be combined in order to attain this result. F.P.H.

Technical developments in the Portland cement industry in 1927. ANON. *Rock Prod.*, **30** [26], 110–11 (1927).—There is no proof that early high strength Portland

cements are of any greater ultimate value in construction than ordinary Portland cement; and there is a possibility that early high strengths are attained at the cost of ultimate strength and permanency in the resulting concrete. The belief in early high strength Portland cement appears to be founded on the theory that the most active and desirable component in Portland cement is tricalcium silicate. The proportion of this component may be increased by fine grinding of the raw materials and a higher lime content; the finer grinding and the greater refinement in proportioning and fusing will bring about the combination of more calcium silicate in the tricalcium silicate ratio. There are other ways of accomplishing the same result, and doubtless still more will be discovered. Finer grinding of the cement up to a certain point helps in making it quicker acting. At one new plant this was determined to be 88% through 200-mesh; beyond this point the cement became too fine for the water to react on it readily, and there was no increase in the activity or resulting strength of the cement mortar from grinding beyond this fineness. To a certain extent early high strength in Portland cement is an index of the care and thoroughness used in its manufacture. With it goes also the assurance of greater uniformity, because of more accurate chemical control. Other things being equal, it is obvious that the user will demand early high strength, if he can obtain it at the same price as slower hardening cements, until it is proved whether such early high strength cements are equal to the standard cement in permanency or ultimate strength. There is no question but that it will be more costly to the manufacturer to furnish early high strength cement in place of the present standard material, but it is less costly to make it in the new plants specifically designed for this purpose, than in the older plants. Consequently, as the number of new plants increases, the pressure on the older ones becomes greater. F.P.H.

Electrical precipitation in the cement industry in 1927. ANON. *Rock Prod.*, **30** [26], 113 (1927).—The application of electrical precipitation in the Portland cement industry has gone forward less rapidly than the application in the metallurgical industry, where large quantities of metal values can be recovered. Steady progress is being made nevertheless and at the present time the gases from over 100 kilns with an output of close to 100,000 bbls. per day, are being cleaned by the Cottrell electrical precipitation process. These installations are in many instances also treating the gases from the stone and clay driers. With an adequate central dust recovery installation, all mill equipment can be vented and the dusty air can be sucked up at every point and carried into the flues leading into the central dust recovery apparatus. F.P.H.

Cement, lime, gypsum, and stone at the Bureau of Standards in 1927. ANON. *Rock Prod.*, **31** [1], 57–60 (1928).—A summary is given of investigations in progress at the Bureau of Standards on cement, lime, gypsum, and stone. F.P.H.

The expansion of a calcined gypsum during setting. J. A. MURRAY. *Rock Prod.*, **31** [2], 88–92 (1928).—Expansion of a gypsum plaster on setting may be controlled within certain limits by proper control of conditions and admixtures. F.P.H.

Lime-burning practice based on European and American observations. I. VICTOR J. AZBE. *Rock Prod.*, **31** [2], 84–85 (1928).—A. outlines the different kinds of limestone and the various types of kilns. In this country ordinarily high calcium or dolomitic lime is produced exclusively; in Germany and France much mildly hydraulic and strongly hydraulic lime is burned. F.P.H.

Study of hard finish gypsum plaster. T. N. MCVAY. *Rock Prod.*, **31** [2], 92 (1928).—Plasters of high strength may be made at a relatively low cost in commercial practice and their field of use extended. Treatment of gypsum with soluble sulphates before or after final calcination produces plasters of widely varying physical properties, the before-calcination treatment causing the plasters to be made plastic but having a higher shrinkage. Potash alum in general yields more satisfactory results than Glauber's

salt, but other soluble salts may be as efficient as either of these. The physical properties of the plaster can be controlled to a considerable degree by the temperature of the calcination, assuming the concentration of the soluble sulphates to remain fixed. The higher the temperature of calcination (within these investigation limits) the lower the reactions taking place in setting. The greater strength of plasters calcined at high temperatures compared with those calcined at low temperatures is probably due to a more thorough crystallization of the former and also the smaller amount of mixing water used, thus producing plasters of greater hardness and density. F.P.H.

Aluminous fused cement and its application to reinforced concrete construction and stucco. ORTHAUS. *Tonind. Ztg.*, [64], 1130–35; [65], 1151–53 (1927).—A considerable number of tests were carried out on two types of cement, (1) a fused cement designated as "Alca," (2) a high quality Portland cement designated as "S" brand. The material was to be used around a gas works and several factors favored the use of the aluminous cement. Its early strength, its resistance to ammonia and sulphate salts as well as its resistance to a continued temperature change which it is required to withstand made the aluminous fused cement the most desirable for this purpose. The successful patching of old corroded concrete is described. F.P.H.

Effect of pulverized trass admixture to Portland cement mortar. ANON. *Tonind. Ztg.*, **87**, 1585–86 (1927); *Rock Prod.*, **31** [2], 96 (1928).—Frequently one encounters vague conceptions of the effect of finely-ground trass in Portland cement mortars. It is the best and cheapest method to counteract free lime produced as a result of the action of aggressive solutions or sea waters. The soluble silica of trass or puzzolans reacts the more readily the finer it is ground and the more intimately it is mixed with the cement. Other mineral admixtures result only in increased density of the mix, acting as pore fillers, with its consequent advantages, but cannot prevent deterioration when free lime is formed. Tests were made by the laboratory of the Bavarian Portland Cement and Trass Co., Möttingen, on specimens of neat Portland cement, mixes of 3 parts Portland cement to 1 part trass, 2 parts Portland cement to 1 trass, and 2 parts Portland cement to 1 trass and 1.5 parts lime hydrate, combined with standard sand to 1:3 mortar, cured 24 hours in air and the remainder in water. The tensile strength of all specimens increased uniformly during the first 2 days. On the 3rd day neat Portland cement was above the other values, but was equaled on the 26th day by the 3 parts cement to 1 trass mixture, and on the 60th day by the 2 parts cement to 1 trass mixture. The strengths of the trass mixtures continued to increase and were considerably above those of neat cement at 90 days. It may, therefore, be concluded that during the last 2 months of hardening a new substance was formed in the trass mortars, which considerably benefited the hardening. The cement-trass-lime mixture remains parallel to the neat cement mortar after 28 days. It is apparent that the action of trass is here counteracted by the addition of lime. Similar results were obtained for compressive strengths. The effect of trass admixtures becomes evident somewhat later than in the tensile tests. Nevertheless, the curves of the trass mixtures are considerably steeper than those of neat cement after 28 days. The counteracting effect of the hydrate in the presence of trass is even more apparent here, as the curve flattens out after 28 days. The following strengths were obtained for a mix of 3 parts (by weight) Portland cement clinker to 2 trass to 15 standard sand tested up to 90 days:

Age (days)	Tension (lb. per sq. in.)	Compression (lb. per sq. in.)
3	170	1700
7	297	3110
28	410	5100

F.P.H.

Flow of heat through limestone and lime. R. T. HASLAM AND V. C. SMITH. *Ind. Eng. Chem.*, **20** [2], 170–74 (1928).—This work supplements work on the rate of heating

of solids by Gurney and Lurie. The methods of the latter are extended to solids such as limestone in which heat is utilized or liberated in effecting some chemical or physical reaction. The rate of heating is discussed as well as the rate of dissociation of limestone. From mathematical and experimental considerations a method is obtained for estimating the time necessary for complete dissociation of spheres under different conditions of preheat and with different surface temperatures. R.J.P.

Sand for use in lime plaster. ANON. A.S.T.M. Comm. Repts., Part I (Series C66–27T), pp. 774–75 (1927).—Sand is the fine granular material resulting from the natural disintegration of rock, or from the crushing of friable sand-stone rocks. For use in lime plaster the general requirements are grading, sieve analyses, decantation test, and organic impurities. These are tentative specifications. R.A.H.

Limestone, quicklime, and hydrated lime. ANON. A.S.T.M. Comm. Repts., Part I (Series C25–27T), pp. 776–91 (1927).—Starting with treatment of sample, methods of determination of silica and insoluble matter; iron and alumina, total iron, aluminum, calcium, strontium, magnesium, volatile matter, mechanical moisture, carbon dioxide, sulphuric anhydride, total sulphur, phosphorus, manganese, ferrous iron, are given. A method for the preparation of standard solution of potassium permanganate is included. These are tentative chemical analysis methods. R.A.H.

The gypsum industry. ANON. A.S.T.M. Comm. Repts., Part I (Series C11–27T), p. 793 (1927).—Definitions are given for aggregate, consistency, gypsum molding plaster, gypsum plaster board, pottery plaster, wall board, Keene's cement and plasticity. These definitions are tentative. R.A.H.

Tests of fluid cement-water mixtures. ANON. A.S.T.M. Comm. Repts., Part I, pp. 307–12 (1927).—The purpose of these tests is (1) to compare strength tests on fluid cement-water mixtures; (2) to study the day-to-day uniformity of strength tests; (3) to study the effect of varying the quantity of mixing water in fluid cement-water mixtures; (4) to study the flow cylinder test for consistency of fluid cement-water mixtures, and (5) to study the possibilities of a 1- or 3-day strength test for Portland cement. The conclusions given are as follows: This investigation is somewhat inconclusive from the standpoint of uniformity of tests on a given cement by the 12 laboratories using fluid cement-water mixtures in the form of 2-in. cubes as compared with 1:3 standard sand briquets. When the two forms of test are compared on the basis of day-to-day variation for a given laboratory and the variation of the 3 specimens from the same batch, the fluid cement-water mixtures give more favorable results. A comparison of the data obtained from the 12 laboratories coöperating show that the present standard mortar briquet gives the most favorable results. The use of a fluid cement mix containing about 41% of water by weight of cement seems to be most suitable for a compression test. The fluid neat cement mixture presents the possibility of a 3-day test with fairly uniform results. R.A.H.

Lime. (Report of Comm. C7.) ANON. A.S.T.M. Comm. Repts., Part I, pp. 324–29 (1927).—A new method for determination of mechanical moisture and an alternative method for the determination of carbon dioxide have been added to tentative methods of chemical analysis of limestone. R.A.H.

The tensile strength of Portland-cement constituents. JASPER O. DRAFFIN. *Proc. A.S.T.M.*, **27** [2], 313–23 (1927).—A method of estimating the strength of Portland cement at various ages from a study of the variation in the strengths of the 3 principal constituents. Data on the strength of the 3 constituents, prepared from pure materials and tested in tension, have been taken from publications of the U. S. Bureau of Standards and used to estimate the strength of an average Portland cement. Comparison is made between the computed and the actual strength. The computed strength is lower than the actual strength, but the shape of the age-strength curve agrees with that of one of

the curves determined by experiment. This method of estimating the strength of cement is not practicable as a general method but is suggestive of future possibilities. The need for more data is emphasized. R.A.H.

Long-time test of high-magnesia Portland cement. P. H. BATES. *Proc. A.S.T.M.*, **27** [2], 324–34 (1927).—This paper presents data obtained in testing a number of cements prepared in the U. S. Bureau of Standards' experimental cement plant, containing from normal to very high percentages of magnesia. The data obtained in testing at early ages and a detailed discussion have already been presented in *Tech. Paper* No. 102 of the Bureau of Standards. This paper contains in addition data obtained in testing concrete made from the cements at the end of 10 years. With care in manufacture, a satisfactory cement could be produced containing 6.5% of magnesia. Such cements would have lower early strengths than those of lower magnesia content, but show a sufficiently marked gain in strength with age to justify classing them with normal cements at later ages. Ten-year strengths of concretes made from cements containing as much as 14% magnesia showed no marked disintegration. R.A.H.

Improved brick mortars. LAURENCE E. WEYMOUTH. *Proc. A.S.T.M.*, **27** [2], 446–64 (1927).—Results of a series of tests on 60 different brick mortars, ranging from very plastic to very lean mixes, are given. The mixes were made up to the same consistency as measured by the slump of a 2- by $2^1/_2$-inch cylinder of the mortar. The plasticity was measured on an Emley plasticimeter according to a method modified somewhat from the standard A.S.T.M. method for the plasticity of hydrated lime. Six 3- by 6-inch cylinders and 6 standard briquets were made in each case for compressive and tensile strengths at 28 days and 6 months. The specimens were stored in a damp room. Five pairs of bricks were laid up with each mix and tested at 28 days to measure the adhesive strength of the bond. The times of initial and final set and the weight per cubic foot were observed in each case. Three cement-sand ratios were used: 1:6, 1:12, and 1:18 by volume, and varying proportions of hydrated lime and diatomaceous silica. Considerable time was spent in working out satisfactory methods of testing, as there are at present practically no standard tests applicable to brick mortars. The results bring out some interesting relations between the plasticity, strength, and composition of mortar mixes and show particularly how a large increase in strength may be obtained by the use of diatomaceous silica. R.A.H.

Heat changes during the setting of alumina and Portland cements. A. A. JAKKULA. *Eng. News-Rec.*, **99** [24], 955 (1927).—The setting of cement is chiefly a chemical action accompanied by heat. Alumina cement behaves differently from Portland cement. The testing apparatus, methods of measuring temperatures, and heat developed are described. Three figures are given showing temperature curves of neat alumina cement using variable initial temperatures, temperature curves of various mixes using the same initial temperatures, and the comparison of the heat generated by various mixes of alumina and Portland cements. J. concludes that (1) neat alumina cement specimens, with the heat confined, give a temperature above the boiling point of water due to the chemical action of setting and hardening; (2) a decrease in the richness of the mix reduces the temperature rise; (3) the alumina cement specimens reached a temperature 4 times that of a similar Portland cement specimen; (4) with alumina cement, a temperature rise of 100°F took place in approximately 15 minutes; (5) a high initial temperature causes quick setting of an alumina cement mix; (6) for the same mix and water-cement ratio the alumina cement specimens generated over twice as much heat as Portland cement; (7) at initial temperatures below 80°F the temperature of alumina cement concrete will start to rise in about 5 hours. G.W.W.

The action of pure water on hydraulic cements. RENGADE. *Ciment*, **32**, 370–72 (1927).—Distilled water falling on halves of briquets first washed the surface grains of

sand bare in 5 to 12 weeks and then dug out a crater. A specimen made of an aluminous cement withstood the attack for 100 weeks. A super-Portland cement was next best while lime was the poorest. The calcareous Rhone River water had no effect on the specimens. (*C. A.*)

The constitution of the clinker of Portland cement. I. ALEKSANDROV. *Jour. Russ. Phys.-Chem. Soc.*, **58**, 1362–72 (1926).—Powdered clinker (10 g.) removes 62.7% of naphthene acids (molecular weight 188) from 11.8% solution in dry benzine. The phenomenon does not conform to the adsorption equation which seems to indicate its chemical nature. Ca salts of the naphthene acids of molecular weight 160–170 were found in the ether extract and proved easily soluble in benzine. Salts of acids of molecular weight 210 swell in benzine and at the end of 3 days can be dispersed by shaking. Ca salts of the acids of molecular weight 310 (from solar oils) swell but do not disperse. The absorption of naphthene acids increases with the degree of dispersion of the clinker, *i.e.*, CaO is quite evenly distributed throughout its mass. When free CaO is converted into $CaCO_3$ by treating the clinker with dry CO_2, the amount of the naphthene acids absorbed falls from 50% to 0.1–0.2% (probable experimental error). The addition of naphthene acids to cement results in the formation of films of Ca soaps insoluble in water which prevent the latter from coming into contact with lime. The reaction between naphthene acids in dry benzine (C_nH_{2n+2}) must occur between whole mols. (*C. A.*)

Water-soluble alkali salts in cement. F. KILLIG. *Zement*, **16**, 422–23 (1927).—The presence of 0.5% and 1% K_2S reduced the strength of fresh cement about 15 and 25%, respectively. CaS has a similar though smaller influence. (*C. A.*)

BOOK

German Cement and Concrete. (Die Deutsche Zement Industrie.) RIEPERT (assisted by QUIETMEYER, SCHOTT, AND HAEGERMANN). Reviewed by P. H. Bates in *Eng. News-Rec.*, **99** [24], 969 (1927).—A record of the development of the cement industry in Germany is given. The first part of the volume gives the historical background of cement. The development of Portland cement is worthy of particular attention. Part II is devoted to concrete with a small part given to the design of concrete mixtures and the remaining portion to the application of concrete in structures. Discussion of the various moduli, ratios, etc., is lacking. The last part is of value only from a financial viewpoint. The large volume is typical of German thoroughness. G.W.W.

PATENTS

Cementitious composition. JESSE A. MCCORMICK AND CHARLES A. CABELL. U. S. 1,656,984, Jan. 24, 1928. A cementitious composition comprising hydrated lime, an aluminous material, a sulphate and a carbonate.

Cement-kiln system. DAVID S. JACOBUS. U. S. 1,658,443, Feb. 7, 1928. The combination with a plurality of rotary cement kilns arranged in a substantially parallel series, of a horizontally extending flue common thereto, and draft-producing means connected to the common flue beyond the series of rotary cement kilns, the connections between the kilns and the common flue being arranged to equalize the flow of gases through the several kilns irrespective of their relative distances from the draft-producing means.

Fused cement from phosphate slags. Brit. 267,518; *Rock. Prod.*, **31** [2], 96 (1928).—Iron ore or scrap iron is added to reduction wells or slags containing phosphates, with further addition of alumina, lime, and silicas (optional), the amounts depending on the quantity already present in the wells and the desired cement composition. Sufficient iron is added to combine with all the phosphorus in the well. F.P.H.

Tunnel kiln production of cement. Fr. 612,391; *Rock Prod.*, **31** [2], 96(1928). The raw material is conveyed in small wagons through a tunnel kiln in which it passes successively through a drying and causticizing zone, a clinkering zone, and a cooling zone. F.P.H.

Enamel

White enamel and gray hair. R. D. COOKE. *Jour. Amer. Ceram. Soc.*, **11** [3], 126–30(1928).—The causes of opacity are discussed and examples listed. The chief cause is the great difference in indices of refraction of materials intimately mixed. The explanation of white enamels is given, discussing the effect of thickness on the reflection factor, and the intrinsic whiteness of enamels.

Modern research on the structures of metals. WHEELER P. DAVEY. *Jour. Franklin Inst.*, **205**, 221–28(1928).—X-ray work is useful in industrial research laboratories in the solution of factory problems such as locating faulty spots in castings, impurities such as splinters of wood, hair pins, and tin foil in mica insulation and even in examination of shoes for nails in the soles. X-rays have been found to be particularly useful as an aid to development work. The density of materials can be obtained by measuring the lattice perameter of the crystals. It is also useful in determining the presence of impurities. The greatest usefulness on X-ray bulbs lies in the discovery of new facts. X-rays are applied to metals and alloys as a means for explaining the facts regarding the physical properties of these materials. J.T.L.,

Prevention of cooling cracks in sheet-metal enameled ware. W. SCHEFFEL. *Keram. Rund.*, **35**, 824–25(1927).—To prevent cooling cracks in enameled ware a corrugated metal sheet which has been welded in one or two places to a plane metal sheet is substituted for the usual plane metal sheet on which the ware is placed after being taken from the furnace. The edges of the plane sheet are turned over to entrap the air in the corrugations of the under sheet and thus to provide a poorly conducting table. H.I.

Rust speck formation in enamels. HUGO SCHULZ. *Keram. Rund.*, **35**, 843(1927).—Rust specks may be caused by (1) improper pickling of the casting, (2) sulphidic coal dust, (3) delayed removal of the casting from the mold, (4) porous castings, (5) damp air or sand in sand-blasting, (6) graphite specks, (7) improper drying. H.I.

The drying of enameled ware. L. VIELHABER. *Keram. Rund.*, **35**, 865–66(1927).—To conserve space in enameling plants the artificial drying of enameled ware (before firing) is necessary. Special drying rooms using air preheated by waste gases from the enameling furnaces are advantageous. Proper ventilation of such rooms is necessary but care must be taken to prevent drafts. The use of tunnel driers is suggested. In tunnel driers the ware may be moved at a rate of 0.5 meters per minute. Where the air temperature is 75°C, ware may be completely dried in 30 minutes and the tunnel drier must therefore be at least 15 meters long. Where waste heat is not available special air heaters may be provided. H.I.

The Ferro wet process of vitreous porcelain enameling. W. MARSHALL. *Foundry Trade Jour.*, **37** [587], 124(1927).—The castings must be of good quality, free from dust and slag, and have a smooth even surface free from sand and blow holes. The patterns to make the castings should be of metal. Thick or thin spots in castings cause "cold shots" which are liable to crack during firing. Sharp-cornered and angled castings should be avoided. The down face of the casting should be enameled. The gates should be on the edge and not on the face. The castings should be poured from the middle of the heat and not exposed to the weather or stored where they will absorb moisture. Eliminate foundry facings if possible, because if included in the iron and not removed in the sand-blast they will oxidize under the enamel emitting gas during the firing causing bubbles. Avoid printing and returning the pattern. The ideal cupola

mix composition for casting suggested is as follows: CC 0.63, Gr 3.05, Si 2.5–3.0, Mn 0.44–0.54, S 0.65–0.9 and P .64–.69, GC 3.05. The use of new iron will more than counterbalance its extra cost. G.W.W.

Examination of enamels. L. N. MURAWLEFF AND P. O. GRIGORJEW. *Sprechsaal*, **60** [51], 959–62 (1927).—Methods for the examination of the raw materials, frits, and products of the enameling industry. R.A.H.

Preparation of metal ware for enameling. FRITZ KROYE. *Sprechsaal*, **60** [52], 1048–50 (1927).—A review of the developments which have taken place in the work on sheet metal and cast-iron ware for enameling during the past 50 years. R.A.H.

Enamel sanitary ware by continuous process. ANON. *Ceram. Ind.*, **10** [2], 163–64 (1928).—Most enameling plants engaged in the manufacture of cast-iron sanitary ware use either the single- or twin-hand operated furnace of the intermittent type for firing. There are usually three coats of enamel applied. The methods of applying and firing these enamels might be improved and suggestions toward this end are given. A diagram of the proposed plant for continuous sanitary cast-iron enamelware is given. After the tub emerges from the continuous sand blast it is turned upside down on special rack and first coat either sprayed or painted on. It is placed on a conveyer, sent through a drier, and if necessary can be inspected along conveyer during the interval between drier and point where it enters the heating chamber or grip coat continuous furnace. There are two doors, one at either end of each of the furnaces and because of the comparatively slow movement of the ware each piece is placed in these chambers before and after firing to prevent serious heat loss in the main firing chamber. After each piece comes from a furnace it is shunted either left or right to dredging tables and then placed again on the conveyer for first cover and second or finish coats. After passing through the second-coat furnace inspection could again be made while on the conveyer, and pieces could be turned upside down for their travel through the continuous paint-spraying booth. F.P.H.

Influence of smelting on acid resistance of enamels. T. SCHAUER. *Ceram. Ind.*, **10** [2], 166–88 (1928).—The results of a number of tests on the effect of smelting upon the acid resistance of enamels are summarized. (1) The violence of attack by solutions is in exact ratio to their degree of dissociation. (2) Resistivity is greatly diminished by bad cooling. (3) Resistivity of enamels is enhanced in proportion to the degree of resistance which the raw material combinations in the frit offer of themselves to chemicals. (4) Resistivity of enamels increases when fusion has incorporated into the frit a combination of low solubility in the presence of the solvents for which it is intended. This is true even though individual materials before fusion may possess a relatively high degree of solubility. (5) Ready disintegration of an enamel is predicated on greater solubility. (6) Lixiviation proceeds the more rapidly, the more easily soluble the salts formed in the solution. (7) Dissolution of enamel diminishes under repeated treatments, never, however, to the zero point. F.P.H.

Effect of temperature on the solubility of iron oxide in iron. C. H. HERTY AND J. M. GAINES. *Min. and Met.*, 9 [254], 78 (1928).—The solubility curve for FeO in pure iron has been determined between the temperatures 1535 and 1750°C. Slags ranging from 40 mol. % FeO up to nearly pure FeO were employed, the diluent constituents being chiefly CaO and MgO. The solubility at 1535°C is 0.94% FeO (0.21% O_2); at 1600°C, 1.36% FeO (0.304% O_2); and at 1700°C, 2.02% FeO (0.452% O_2). It is shown that FeO in the slag dissolves in iron as the compound FeO. It is also established that if any compounds are formed between lime and oxides of iron in the slag, these are broken up at the slag-metal surface so that all of the FeO is free to dissolve in the iron. F.P.H.

Testing iron by electrical resistance. W. A. FORBES. *Amer. Iron Steel Inst.* (Advance Paper, N. Y. Meeting), pp. 77–78 (1927).—The fact that C and other elements

increase the electric resistance of iron has been utilized in the laboratories of the U. S. Steel Corp. to develop a quick method of checking the grade of metal. A bar of the metal is tested in series with a bar of standard composition. If the two bars are of the same grade there is no swing of the galvanometer needle. The standards are given. H.H.S.

New enamel plant in Canada. ANON. *Chem. and Ind.*, **47**, 8 (1928).—The Ferro Enamel Co., Canada, Ltd., a subsidiary of the U. S. company at Cleveland, proposes to construct a factory either at Ottawa or at Kingston. Feldspar is available from a mine in Frontenac County. H.H.S.

Manufacture of titanium white. A. DULAC. *Rev. chim. ind.*, **36**, 263–66, 294–97 (1927).—A description of its common manufacture, based mainly on French patents. (*C. A.*)

Glass

The determination of iron in glass sand. G. E. F. LUNDELL AND H. B. KNOWLES. *Jour. Amer. Ceram. Soc.*, **11** [3], 119–25 (1928).—Data are presented in tabular form showing the determination of iron in the Bureau of Standards Sample of Glass Sand, No. 81. The electrometric titration, H_2S reduction, and gravimetric methods are described in detail.

Fluorspar, cryolite, and artificial cryolite as opacifiers in the glass industry. HUGO KÜHL. *Keram. Rund.*, **35**, 823–24 (1927).—K. has observed that (1) small quantities of fluorspar, sodium fluoride, sodium silico-fluoride, and cryolite act always as fluxes; (2) opacity is produced as soon as a certain upper limit, which is different for each opacifier and very high for fluorspar, is exceeded; and (3) with an opacifier present, glass which is usually clear becomes milky-white when it is reheated and slowly cooled. Cryolite is considered a better opacifier than fluorspar because of the smaller quantity required. Since Greenland is the only commercial source of cryolite, synthetic cryolite is suggested as a satisfactory substitute. H.I.

Requirements for a pure red lead for glass making and methods of analysis. RUDOLF SCHMIDT. *Keram. Rund.*, **35**, 840–43 (1927).—Although pure red lead contains 65.11% PbO and 34.89% PbO_2 commercial red lead also contains varying amounts of Pb_3O_4 and often as little as 24–26% PbO_2. Red lead with low PbO_2 content used in glass batches make the glass difficult to melt and to refine. "Scarlet-red" lead (crystalline red lead) is more satisfactory for glass making than "brick-red" lead which is more pulverulent. The oxides of antimony and tin and $PbSO_4$ are the principal impurities in red lead which has not been deliberately adulterated. Other impurities are Fe, Cu, and Co. For glassmaking purposes Fe_2O_3 should not exceed 0.005%, CuO 0.002%, and Sb_2O_3 0.006%. A chemical method for determining the purity of the red lead and for determining qualitatively the nature of the impurities is given as well as the detailed method for quantitative chemical analysis. H.I.

Protective glasses. H. MEESS. *Keram. Rund.*, **35**, 859–61 (1927).—Results of measurements of transmission on special glasses for eye protection used in certain industrial operations such as welding are given for the ultra-violet, visible, and infra-red portions of the spectrum. H.I.

Glass pots and their design. H. SCHNURPFEIL. *Sprechsaal*, **60** [47], 874–77 (1927). —A general discussion on glass melting in pots with a description of, and advantages in using a newly designed pot having a channel extending along the diameter of the base. R.A.H.

A review of the bottle (glass) group in a 4-dimensional diagram after Zschimmer. T. CANTOR. *Sprechsaal*, **60** [48], 891–93; [49], 920–22; [50], 941–43; [51], 962–66 (1927). —256 analyses and syntheses are given of representative glasses taken from the bottle group of the 4-dimensional system. R.A.H.

History of glass research. E. ZSCHIMMER. *Sprechsaal*, **60** [52], 1016–22 (1927).—Outstanding events during a period of 60 years in glass research as accomplished by C. Nehse, M. Miller, O. Schott, R. Weber, F. Reinitzer, R. Zsigmondy, are recorded in *Sprechsaal*. R.A.H.

Development in physics of glass. H. SCHULZ. *Sprechsaal*, **60** [52], 1022–23 (1927). —A short review covering the past 60 years. R.A.H.

Influence of technical physics on the technology of glass. G. GEHLHOFF. *Sprechsaal*, **60** [52], 1024–25 (1927).—How the development of knowledge on the analyses and constitution of glasses has led to knowledge regarding the physical properties. R.A.H.

Glass manufacture by machinery. A. WENDLER. *Sprechsaal*, **60** [52], 1025–29 (1927).—A review of the progress and development of glass working machinery since 1868. R.A.H.

White hollow glassware manufacture. F. ECKERT. *Sprechsaal*, **60** [52], 1030–34 (1927).—Little change is shown in composition of these glasses in 50 years. Discussion on decolorization, full and half automatic finishing, positive distribution and its suppositions, and various methods of shaping the glasses. R.A.H.

Construction of glass furnaces. HUGO KNOBLAUCH. *Sprechsaal*, **60** [52], 1041 (1927).—Development of the different types of furnaces used in this industry for 60 years is briefly reviewed. R.A.H.

Devitrification of glasses. (Suppl. to 4th Rept.). KOZO TABATA. Electrotechnical Laboratory, *Research*, No. 211 (1927).—The same method of surface devitrification by heat as described in the previous papers by T. has been applied to glasses consisting of R_2O, MgO, and SiO_2. In the experiments with other kinds of glasses, it was necessary to seek the points of no devitrification for each series of melts by previous experiments, as shown in *Researches* Nos. 175 and 191. In this case, however, by analogy with the results obtained in the foregoing experiments, the boundary lines of devitrification for each series of glasses, R_2O, 0.5MgO, $y SiO_2$; R_2O, 1.0MgO, $y SiO_2$; R_2O, 1.5MgO, $y SiO_2$; and R_2O, 2.0MgO, $y SiO_2$, have been assumed; namely that MgO combined with MgO, $2SiO_2$, and also that molecules of MgO, $2SiO_2$ dissolved no silica. The conditions and results of the experiments are summarized in tabular form. Considerable crystallization of magnesium silicate during the forming of the samples prior to the devitrification experiment occurred in glasses containing more than 1.5 mols of MgO and having a molar per cent of K_2O in alkalis below 40%. Weathering action was marked in glasses containing less than 0.5 mols of MgO to 1 mol of R_2O, a fact common to all other kinds of glasses. From the results of the experiment T. gives the constitution of the glasses as R_2O-MgO-SiO_2; R_2O $2SiO_2$+MgO $2SiO_2$+SiO_2. E.J.V.

Plate glass polishing machines. I. F. W. PRESTON. *Glass Ind.*, **9** [2], 27–29 (1928). —A nonmathematical account of the theory of plate glass polishing written for the layman. It is intended to explain and amplify P.'s mathematical treatise on the same subject. (See *Ceram. Abs.*, **6** [10], 431 (1927).) What happens when glass is polished has been the matter of a great deal of debate. Some contend that the ground surface is liquefied by the drag of the polisher and, as it were, is spread about like butter on bread. Others contend that polishing is really just an exceedingly fine grinding operation. Experiments have shown that glass is completely removed from the main body of the glass and may be collected later from the polisher. Rate of polishing is defined as the rate at which glass is being removed at a given spot, and is about $^1/_{2000}$ of a cubic inch per square foot per minute in a good modern plate glass machine. E.J.V.

Fabrica Mazda. ANON. *Glass Ind.*, **9** [2], 37 (1928); abstracted from General Electric Co., *The Digest*.—A description of a modern incandescent lamp making factory set up in Rio de Janeiro in 1921. It is owned by General Electric, S. A., and has the

advantages of intimate contact with all the improvements taking place in the factories and laboratories of the General Electric Co. in the U. S. E.J.V.

Electrolytic chromium plating of glass molds and cylinder materials. KURT ILLIG. *Glastech. Ber.*, **5** [6], 241–52 (1928).—On the iron molds used in the glass industry, especially in the production of pressed and hollow glassware, it is imperative to use a protective agent which will furnish resistance to thermal, chemical, and atmospheric influences. Among the various materials to be considered for this purpose, chromium predominates. A nickel-chrome-iron alloy is so hard that it is almost impossible to make molds from it. Soft gray cast iron with a hardening, protective coating makes a mold that is resistant to thermal, chemical, and atmospheric corrosion. Galvanic deposition of chromium is the best. Sargent uses an electrolyte containing 245 g. of chromic acid per liter plus small quantities of chromium sulphate. His current density amounts to 1000 amperes per square meter. The chromium plating itself is done in different ways and depends on the material to be protected, as well as the kind of corrosion from which protection is desired. Besides furnishing protection from corrosion the chromium deposit, due to its extreme hardness, provides for an increased capacity of resistance of the basic metal to friction, shocks, and percussion. In many cases small additions to the electrolyte of other metal salts, such as copper sulphate, will improve results. Special care should be exercised to control the proper content of uncombined sulphuric acid in the solution. The galvanic process is carried on in vessels which in smaller plants consist of earthenware. Iron vessels coated with a special kind of enamel or with an acid-proof layer, as well as wooden vats lined with lead sheeting, or aluminum vessels, may also be used. In America steel vessels are used. The anodes are strips of lead which are hung into the solution; the objects to be chromium plated are attached to cathode bars. In order to plate articles of various sizes in the same solution the electrolyzing vessel is provided with movable electrode bars. The temperature of the solution should be 20°C for dull deposits and 35°C for bright deposits. The effects of shape, type of iron, etc., are discussed and illustrated. A chromium deposit will prevent corrosion, keep the contours of the design sharp and the surface smooth, and the glass will detach completely. Frequent cleaning will be eliminated. In some cases more than 150,000 objects were pressed in the same mold without any cleaning or recarving; it was merely blown out and wiped off. The outlines were all of the same sharpness and had the same bright polish. Chromium plating is very inexpensive. E.J.V.

The thermometer industry in Thuringia. H. FISCHER. *Glastech. Ber.*, **5** [7], 307–30 (1927).—The thermometer industry is a branch of the lampworking industry of Thuringia, which developed about the end of the 18th Century. It owes its existence to the older glass manufacturing industry of the region, which succeeded in producing a glass especially adapted to lamp working, due to the alumina content of the sand used, which prevents devitrification during the period of softening of the glass. The city of Lauscha must be considered the birthplace of the industry, a city famous for its manufacture of glass beads and glass jewelry. From there it spread to Stützerbach. In the city of Thuringia thermometers were first made on a factory scale. Berkes made the first ones. The year 1830 marks the beginning of the thermometer industry in Thuringia. F. F. Greiner of Stützerbach made 64 varieties of hydrometers and thermometers. After his death in 1855 a number of his employees went into business for themselves. The potash-soda-lime glass which had been used up to the year 1850 was replaced by a pure soda-lime glass by Friedrichs without realization of the advantages of this change, *i.e.*, the small thermal afterchange of the glass. The lowering in quality caused by using both alkalis was the reason for beginning the systematic research by the Imperial Standards Committee and the laboratory of glass technology of Jena.

The result of this study was a recognition of the fact that glasses which contain only one alkaline constituent give a thermometer glass having only a small depression of the zero point and subsequent rise of the latter. The firm of Schott & Gen. of Jena, since the year 1885 has made so-called normal glass, known as 16^{III}. At the request of the government the firm of Greiner and Friedrichs, Stützerbach, began making this kind of glass in 1886. Since 1914 it is also being made by the Glassworks Gustav Fischer, and since 1926 by the Glassworks Sophienhütte, Ilmenau. Since 1860 clinical thermometers have been manufactured in various forms. In 1870 the English prismatic clinical thermometer was made. The state established in 1889 an institution for the testing of thermometers. The specifications have been drawn closer and closer. The testing of clinical thermometers has become obligatory since 1921. E.J.V.

The plate glass process of Bicheroux. A. WENDLER. *Glastech. Ber.*, **5** [8], 337–50 (1927); *Glass Ind.*, **8** [10], 231–38 (1927); see also *Ceram. Abs.*, **7** [1], 16 (1928). E.J.V.

The nature of the glassy state. E. BERGER. *Glastech. Ber.*, **5** [9], 393–405 (1927).—Not until the past 50 years has there been any discussion as to the nature of the glassy state. The conception has finally been formed that glass is an extremely viscous, amorphous, undercooled solution. This answer to the question, however, has been modified and enlarged through recent investigations. As a result of the new conceptions we now have the view that glass passes through three phases, depending on the existing temperature, *i.e.*, the liquid, the viscous, and the brittle state. The viscous phase is bounded by the higher and lower temperature limits, which are further explained through researches regarding changes in viscosity and the modification of certain properties during the change from the brittle into the viscous phase. The deeper cause of these transformations lies in the fact that glass contains compounds which are easily polymerized. The changes in the molecular structure, characterizing the three phases, are further explained. The dependence of the properties of glass on its previous history is emphasized. Finally a review of the enlarged conception of the glassy, amorphous state is given, and a classification of the various glasses proposed into irreversible and reversible, organic and inorganic, and into glasses consisting of allotropic elements or compounds, and those consisting of complicated solutions. E.J.V.

Make largest optical glass disk. ANON. *Ceram. Ind.*, **10** [2], 155 (1928).—A huge disk of optical glass, to be used as a mirror in a reflecting telescope, which took 8 months to cool has been perfected by the Bureau of Standards. The glass is 70 inches in diameter, 11 inches thick, and weighs about 3500 lbs. After 4 unsuccessful attempts in the Bureau of Standards to obtain a disk of the size required, a unique method was developed. One thousand pounds of cullet (broken glass of the same composition as the glass to be made) and 4600 pounds of sand and chemicals were melted in a single large pot in a gas-fired furnace. The molten glass was stirred by hand for 6 hours and at the proper time the pot was tapped. The molten glass flowed into a mold of the required size, which was especially designed for the purpose. The temperature of the glass when poured was about 2400° F. For one week the temperature was slowly lowered until it reached 1112°. The glass was held at this point for about 4 days to allow the temperature of the glass and furnace to become uniform throughout. At 1112° this particular kind of glass (borosilicate crown) is quite rigid and yet suffciently viscous to yield to cooling stresses without danger of cracking. Beginning on May 8 the glass was allowed to cool slowly at an average rate of 4.5° a day till 860° was reached. It was then annealed at this temperature for 6 weeks, during which time no variation greater than 2° F was permitted. Final cooling was started on Aug. 30 and room temperature was attained on Jan. 16. F.P.H.

Glass making at Paden City, W. Va. ANON. *Ceram. Ind.*, **10** [2], 156-59 (1928).—(1) The method of rolling wire glass at the plant of the Paul Wissmack Glass Co.

is interesting. A ladle of glass is dipped from the tank and cast on the table. Then the wire is inserted into the rolling machine which automatically presses it into the glass. This particular machine has water-cooled rollers and the wire is brought over a bridge-like form which is a part of the machine and into a slot just behind the rollers so that when the rollers clamp to roll the glass, they catch hold of the wire and press it into the glass which pulls it as it is rolled. After the sheet is rolled, an automatic hook pulls the rolled sheet into the leer. When the sheet is in position the hook releases automatically and reposes in position for the next sheet. This leer is 18 ft. wide by 200 ft. long. As the glass reaches the cold end it is inspected, cut into desired widths, packed in boxes, and transported by monorail to the huge storage shed, where there is sufficient space to store 120 cars of glass. The manufacture of opalescent and cathedral glass is described. (2) A device of special interest at the Paden City Glass Co. is the sanding wheel used for finishing off the feet of tumblers. It consists of two large revolving stone wheels about 3 ft. in diameter and above each is located a steel disk attached to a central shaft. In this disk are openings into which the tumblers are set. Above each stone are 2 pipes; through one flows sand for grinding and through the other water to aid in grinding. A small bag of shot is placed in each tumbler as it is set in the disk. This weight keeps the foot of the glass on an even bearing and insures a ground surface that is smooth and level. A minute is sufficient for grinding. F.P.H.

Unit process of glass manufacture. ANON. *Ceram. Ind.*, **10** [2], 160-62 (1928).—A discussion is given of some of the advantages of the single machine tank unit. Some of these advantages are as follows: (1) smaller amount of glass necessary, (2) less time in heating up the individual tank, although the number of operations must be considered, (3) possible better temperature control, (4) less loss through accidents, (5) quicker hot repairs and cheaper cost, although it will mean one repair for each machine, (6) quicker change of glass, (7) less production loss when tank is down, (8) greater all around flexibility. The disadvantages are: (1) limited production capacity per tank, (2) higher initial installation cost. A sketch is given of the type of plant discussed. F.P.H.

Temperature shock-proof glass. ANON. *Ceram. Ind.*, **10** [2], 198 (1928).—A glass which is insensitive to abrupt changes of temperature contains at least 45% silica, 2–15% boron trioxide, and 4–30% lime and magnesia together, according to *Sprechsaal*. It is characterized by the fact that it contains 2–3% alumina and not more than 8% alkali oxide. F.P.H.

The Lovibond color system. K. S. GIBSON AND F. K. KRAUS. Bur. Stand., *Sci. Paper*, No. 547, 46 pp.—The attempt is made to specify in fundamental absolute terms the essential properties of the standard glasses (in particular, the set marked B.S. 9940); to specify in reproducible terms a standard Lovibond scale which should represent the actual colors as closely as possible, irregularities or erratic variations being eliminated, and to provide suitable methods for obtaining the equivalents of actual glasses in terms of the standard scale mentioned. Spectral transmissions are measured visually on the Königs-Marten spectrophotometer between 450 and 690$\mu\mu$ in 10$\mu\mu$ steps, and between 400 and 540$\mu\mu$ photoelectrically, and between 600 and 750$\mu\mu$ thermoelectrically. Photographic measurements are made in certain cases on several glasses. Thus methods overlap and check each other. The integral transmissions for sunlight are computed and checked for certain combinations by direct measurement by flicker photometry. The results occupy 21 pages, tables, and graphs, and show that certain of the gradings, for example, are incorrect, the glasses marked 7.0 R and 6.0 R being practically the same, while there is a big jump between 7.0R and 8.0R. In neutral combinations, the high transmission for red points to the use of cobalt glasses without the addition of copper, which subdues that red band. It is possible to match a given shade by different com-

binations of colors, the loss of light by reflection at surfaces making this possible, although not taken into account in the tintometer instructions. A second set of red and yellow tintometer glasses tested later by the same methods gives results for red glasses which fit the Bureau of Standards curve fairly well, while those for the yellow glasses at wave-lengths below 440$\mu\mu$ fall on a curve of slope a little greater than that of the Bureau glasses. (*J.S.G.T.*)

The mechanical manufacture of window glass. M. BABILLE. *Chimie et industrie*, **18,** 371–80 (1927).—Description of the Fourcault and of the Libbey-Owens processes as carried out industrially. (*C.A*)

Temperatures of the commencement of fusion and of tempering of industrial glass. E. DAMOUR AND A. THURET. *Compt. rend.*, **185,** 939–41 (1927).—The temperature at which fusion begins is denoted by an increase in the dilatation of the glass. The tempering and annealing temperatures of a number of industrial glasses have been shown to be equal, the former being determined by examining the effects of polarized light on rapidly cooled test pieces, and the latter from the point of separation of the 2 dilatation curves of the same glass tempered or annealed. The fusion and tempering temperatures may be confused with those of rapid and slow annealing, respectively. (*B.C.A.*)

Jena thermometer glasses. H. THIENE. *Glas und Apparat*, **8,** 1 (1927).—In 1880, thermometer glasses were inferior, but in 1884 Abbe, Schott, C. Zeiss, and R. Zeiss founded the Jena Glassworks and began to manufacture the Jena Normal Glass 16^{III}. In 1891, the 59^{III} glass was discovered at the Jena works. Then followed Jena Supremax, which withstands 30 atmospheres internally at 635° with a cubical expansion of 104×10^{-7} and a depression constant of 0.01; Jena 2954^{III} with a softening temperature 25° higher than 59^{III} can be used at 535° under a pressure of 25 atmospheres, and shows only 0.05° difference from the platinum theromometer between 0° and 100°. Its depression constant is only half that of 59^{III} and expansion is $0.6128\frac{t}{100}+0.01473\left(\frac{t}{100}\right)^2$ mm./meter. It can be joined to both 16^{III} and 59^{III}, and platinum can be scaled into it so that it is good for making contact thermometers. T. gives tables of comparison between the platinum thermometer and Supremax and 2954^{III}. (*J.S.G.T.*)

The significance of the rare earths in spectacle glass. GEORG JAECKEL. *Glas-ind.*, **35,** 130 (1927).—Reference is made to the early attempts to introduce the rare earths into optical glass. A practical application of neodymium, which gave to glass a rose to lilac tint, was first proposed by G. P. Drossbach in his German Patent 103,441 for "decolorization of glass by a combination of neodymium and erbium." In 1911, in Vol. I. of Dralle's "Glasfabrikation," neodymium was mentioned as a means of decolorizing, but it appears to have escaped general notice, since recently a patent has been issued on the same subject to the Corning Glass Works. The importance of the rare earths in spectacle glass was first recognized in a patent taken out in 1912 by Sanoskopglas, Ltd., of Berlin. The patent is alleged to have arisen from the false assumption that "the rare earths in glass show broad absorption bands in the ultra-violet, and that, by a suitable mixture of the rare earths, these bands contract into one another, so that a glass can be obtained which absorbs all the injurious ultra-violet rays." With it, however, had begun an interesting chapter in eye-protecting glasses. That the fundamental conception which led to the invention of the Sanoskop glasses was false was shown by spectrophotographs taken in the laboratory of the Sendlinger Optical Glassworks. Oxides of the rare earths, didymium, neodymium, erbium, lanthanun, praseodymium, and cerium (amounting to 3%) were respectively added to the frit of a simple spectacle glass and the resultant glasses compared spectroscopically

with Sanoskop glass. The spectrographs showed that the ultra-violet absorption of Sanoskop glass was traceable only to its cerium content, while the other rare earths showed no noteworthy evidence upon ultra-violet absorption. (*J.S.G.T.*)

The use of cullet in glass manufacture. J. CURRIE. *Glass*, **4**, 243 (1927).—While cullet in the batch is beneficial when used between certain limits, its indiscriminate use is liable to cause trouble, and if it comprises more than $^1/_2$ of the batch mixture, stiff and brittle metal is almost certain to result. The grinding of the cullet to a size comparable with that of the remainer of the batch materials and thorough mixing are advocated, since large lumps of cullet sink in the hotter tank metal when charged, and leave the lighter batch on top, thus causing two layers of different viscosities which do not mix and, when worked out, cause a large percentage of breakages. If supplies of cullet run out, the percentage in the batch should be gradually reduced so that the above strata-forming tendency is minimized. (*J.S.G.T.*)

Notes on the production of half-silvered mirrors. H. L. SMITH. *Jour. Sci. Inst.*, **4**, 262 (1927).—Solutions as employed for full silvering, using invert-sugar as the reducing sugar, give patchy and poor colored results. Experiments are tried on the following reducing agents, using 2% ammoniacal silver nitrate: invert-sugar, chloral hydrate ("chloral"), formaldehyde, amidol, quinol, "hypo," hypophosphorous acid, mixtures of invert-sugar with "chloral" and formaldehyde, respectively, and a mixture of "chloral" and formaldehyde. Of these, only the last mixture gives promising results, marred by a pink tinge. A better result is obtained by using a solution prepared from cane-sugar 5 g., tartaric acid 0.6 g., water 50 cc. boiled for 10 minutes, and after cooling adding 10 cc. of alcohol, and finally making up to 100 cc. with water. Of this solution, 2–3 cc. are used with 2 cc. of 10% "chloral". Glycerine alone gives good "full" mirrors, but with or without formalin is useless for half silvering. Dilute solutions of various sorts have been tried without success. Good results are obtained from Adam Hilger's method, the usual scrupulous cleanliness necessary to all such operations being observed. The solutions are: *A*, 10% silver nitrate; *B*, formalin (40% formaldehyde); C, cane-sugar 400 g., alcohol 200cc., nitric acid 10cc., water to 2 liters; *D*, chromic acid 250 g., in $1^1/_2$ liters of dilute sulphuric acid. After swabbing with strong nitric acid, the glass is placed in solution *D* for 5 minutes and rinsed in running water followed by distilled water and placed in the bath prepared as follows: To 20cc. of *A* ammonia is added until the precipitate first produced is just re-dissolved. Silver nitrate is cautiously added until a faint permanent opalescence is produced, and the mixture made up to 100 cc. The glass is placed face up or down in this, and the reducing mixture (5cc. of *B* with 5 cc. of *C*) added, the glass being kept in motion until a red coloration appears, when the liquid is poured out immediately and replaced by a further 100 cc. of silver solution without reducer, the glass being kept in until the desired amount of silver is deposited, usually only a few minutes. It is then well rinsed in distilled water and air-dried. (*J.S.G.T.*)

Coloring agents for glass. HARRY ARNDT. *Kunststoffe*, **17**, 223–25, 252–54 (1927). —The properties and use of various coloring agents for glass are described. (*C.A.*)

Penetrability of various rays through glass. VI. The penetrability of ultra-violet rays through window glass: the influence of iron and manganese on penetrability. SHIGEMASA SUGIE. *Repts. Imp. Ind. Research Inst., Osaka, Japan* **8** [8], 1–22 (1927).—The penetrability of ultra-violet rays through Na_2O-CaO glass containing 0.04–10% Fe is greatly influenced by the presence and somewhat by the condition of Fe. When Fe is present in the oxidized form, the effect of lowering the penetrability is greater than when it exists in the reduced form. In K_2O-CaO glass, however, there is no difference between the 2 forms of Fe. If Fe is reduced with a strong reducing agent such as starch, the color of the glass is greatly deepened and the degree of penetration is slightly lowered, but the character of penetration is not altered. With glass containing both

Fe and Cr the presence of a small quantity of Cr does not influence the penetrability. The low penetrability of window glass, in general, is ascribed to the presence of a large amount of Fe. The penetrability of the ultra-violet rays through glass containing 0.1–10% MnO_2 is not parallel to the depth of the color of Mn. It is greatly decreased by the presence of Mn when the latter is present in amount of more than 1%, while below this amount Mn has only a slight effect. In Na_2O-CaO glass containg Mn, the samples prepared in oxidizing atmosphere showed slightly lower penetrability than the ones prepared in reducing atmosphere. The mode of coloration due to Mn differs between the Na_2O-CaO glass and the K_2O-CaO glass, but there is no difference in their penetrability. When Mn glass is reduced with starch, the characteristic purple color is changed to yellowish brown and its penetrability is also decreased. For previous article see *Ceram. Abs.*, **6** [10], 435 (1927). (*C.A.*)

The fusibility and viscosity of glass. A. LECRENIER AND P. GILARD. *Le Verre*, **7**, 121–24 (1927).—A review of the methods used for finding the fusibility and viscosity of glass. L. and G. measure the fusibility number, *i.e.*, the time which elapses between introducing 1 g. of cold glass into the furnace at a definite temperature and the falling of the first drop of molten glass from a short tube attached to the Pt crucible. The viscosity number is the time between 2 drops. The relative number melts of different compounds being used, agree with previous work. (*C.A.*)

PATENTS

Apparatus for rolling glass. KARL G. KUTCHKA. U. S. 1,657,214, Jan. 24, 1928. The combination in glass-rolling apparatus, having a pair of rolls through which glass is supplied, of cooling means for one of the rolls, comprising a header extending along one of the rolls and having its side hollowed out so as to fit around the periphery of the roll, with outlet means leading through such side, means for supplying gaseous cooling fluid to the header under pressure, a second header at one side of the first header fitting around the roll and having an inlet opening toward the rolls, and means for supplying suction to such second header, flexible packing means being provided between the roll and the outer side of the second header.

Apparatus for making composite glass. WILLIAM OWEN. U. S. 1,657,227, Jan. 24, 1928. Apparatus for applying pressure to a plurality of sheets to be joined together comprising a pair of opposing separable frame members having chambers facing each other, a flexible diaphragm seated across the open face of each chamber constituting a closure thereof, spacing or binding strips lying over the edges of the diaphragms and secured to the frame-members, a supporting casing having a slot or compartment therein just deep enough to receive the frame members when they are fitted against each other, and means for supplying fluid under pressure to each of the chambers, the diaphragms being adapted to receive between them the sheets to be joined together.

Method and apparatus for feeding molten glass. KARL E. PEILER. U. S. 1,657,640, Jan. 31, 1928. The method of feeding molten glass that comprises discharging a continuous deposit of molten glass on an advancing support having a flat supporting surface and periodically varying the cross-sectional area of the deposit.

Apparatus for handling glassware. EDWARD H. LORENZ. U. S. 1,657,680, Jan. 31, 1928. The combination with a chute and a conveyer, of a transferring means comprising a member movable between a position in alignment with the chute and a position substantially perpendicular to the conveyer for transferring articles of glassware from the former to the latter, and means for moving the member from a position in front of the ware on the conveyer to a position to the rear thereof after it has been deposited on the conveyer.

Glass-annealing leer. KENNETH M. HENRY AND PAYSON D. BURTT. U. S. 1,657,797, Jan. 31, 1928. (1) A glass-annealing leer, comprising a furnace structure having

a horizontally extending tunnel, an endless conveyer therein for moving glass articles through the tunnel, the space above the upper run of the conveyer being divided into a heating section and a cooling section, the heating section being provided with means to subdivide it into a plurality of zones, electric heating elements on the sides and roof of each of the zones, and a temperature responsive device in each zone electrically connected with the heating elements therein for automatically maintaining a predetermined temperature therein, and partition means between the upper and lower runs of the conveyer. (2) A glass-annealing leer, comprising a furnace structure having a longitudinally extending tunnel, an endless conveyer therein for for moving glass articles through the tunnel, the space above the upper run of the conveyer being divided into a heating section and a cooling section, a plurality of vertically disposed gates depending from the roof of the heating chamber for dividing the same into separate zones, means operable from the exterior of the furnace for raising and lowering the gates, electric heating elements arranged in each zone, and means responsive to temperature changes arranged in each zone, and electrically connected with the heating elements therein for maintaining a predetermined temperature in such zone.

Roll for rolling molten glass. HAROLD R. SCHUTZ. U. S. 1,659,053, Feb. 14, 1928. A roll for contact with and shaping molten glass, being a hollow cylindrical form for the circulation of a cooling fluid therethrough and having the inner surface of its circumferential wall ribbed to increase the heat radiating surface thereof.

Lens and methods of marking same. G. GALLASCH. U. S. 1,607,395, Nov. 16, 1926. The polished surface of the lens is marked by means of a rubber stamp with a solution of a waxy substance, or balsam, together with a little pigment. This when baked to 200-300°, leaves a visible mark on the lens which can be retained through the factory operations of sorting, testing, etc. When removed in the usual way, the surface of the glass is so affected that the marking stands out in relief when the surface is breathed upon. (*J.S.G.T.*)

Method of manufacturing double-walled glass vessels. W. HODECKER. U. S. 1, 623,311, April 5, 1927. The outer wall of the vessel is blown with a cap, the latter caused to sink as a cup, after introducing a pad of asbestos to support the inner wall, and sufficient glass to form the inner wall put in this cup. Then, by suction, or a suitably shaped mandrel, or external pressure, this glass is caused to sink and form the inside wall. In this case of containers with a neck narrower than the body, the mandrel could be of known expanding form. (*J.S.G.T.*)

Silica receptacles and process for making same. H. A. WAYRINGER. U. S. 1,624,699, April 12, 1927. Long tubes are cut transversely into sections and rods into disks, and from these units beakers are built up by welding processes more cheaply, it is claimed, than by previous means. (*J.S.G.T.*)

Vacuum flask manufacture. F. SIEGHEIM. Brit. 267,005, Sept. 1, 1926. Relates to the method of manufacturing vacuum flasks in which an inner vessel is inserted in an outer vessel having one end closed, and the vessels are welded together along their upper rims. According to the invention, the inner vessel is first formed with a neck which is shorter than that of the finished flask, and after being joined to the outer vessel, is shaped to its final form in a mold. The outer and inner vessels are blown in molds so that the bottoms are of the final shape, and the inner vessel is formed with a short neck having a flange. After the vessels are assembled with asbestos spacers, the upper rims of the two vessels are reheated and joined together, and the neck so formed is worked until it is roughly shaped. The flask is then placed in a mold having a base with a projecting mandrel which is enclosed by mold sections. The neck is then shaped by rotating the flask relatively to the mold and blowing into the space between the inner and outer vessels. The joint between the inner and outer vessels lies on the outside of the neck below the rim and is protected by the metal casing of the flask. (*J.S.G.T.*)

Forming glass reflectors. J. C. Stimson. Brit. 269,760, July 2, 1926. A method of forming central triple reflectors, consists in using a molding-surface or matrix formed by the ends of a number of bars assembled side by side and clamped together, the ends of the bars being suitably shaped to produce a reflector of the desired configuration. In making the reflectors by pressing glass, the press plunger consists of a number of steel bars hexagonal in cross-section, which are assembled side by side and clamped in the press head. The lower ends of the bars are bevelled off to form a series of cubic formations that produce a surface of which each reflecting unit consists of three sides of a cube. By making the plunger in this way, the molding surface can be formed accurately, and it can be renewed when worn by resurfacing the ends of the bars. The bars may be of other suitable shapes, and square bars with ends perpendicular to their axes may be assembled in an inclined position in the body of the mold. Hollow reflectors may be made by depositing metal electrolytically on a pressed glass plate, formed as described, or on a matrix formed by elements similar to the bars. (*J.S.G.T.*)

Frosting electric lamp bulbs, etc. R. G. Phelps and L. Staudenmeir. Brit. 269,535, April 9, 1927. A machine for frosting the inside surfaces of hollow glass articles, such as electric-light bulbs, comprises a rotatable carrier by which the bulbs are moved progressively into a number of stations where washing, wiping, etching, and drying operations are performed in succession. The stations are at one side of the machine, the other side having a duplicate set. The bulbs are seated in holes, in a circular carrier consisting of a series of segments, supported by spokes, fixed to a hub. The carrier is rotated intermittently about a vertical sleeve by a turret, to which are fixed uprights, embracing a spoke, the turret being rotated by a cam, which is fixed on a rotary shaft, and engages rollers on the underside of the turret. To raise the carrier for movement from one station to the next, and to move it up and down several times in quick succession at each station, a cam, also fixed on the shaft is arranged to act on a lever connected by a link, and an adjustable screw to the hub. At the station, the bulbs are washed out by water supplied to nozzles through a valve controlled by a cam, and water remaining on the rims of the bulbs is removed by felt pads supported on fixed vertical rods. At each of the three positions frosting-fluid from a supply compartment is applied to the insides of the bulbs through pipes by means of compressed air supplied through a pipe, the air inlet valve being controlled by a cam. Surplus fluid flows down an incline into a chamber. A valve is subsequently opened to release the air pressure, and a valve is simultaneously raised to allow the fluid to flow back into the compartment, both valves being controlled from a cam acting through links. The frosting-fluid is heated by a hot-water tank in which an electric heater is arranged. Frosting-fluid of less concentration for strengthening the bulbs is supplied and controlled in a similar manner. The operations are repeated in the same order at the stations, the bulbs are washed out, and a final strengthening treatment is effected by weak fluid supplied through pipes. The bulbs are again washed, the insides are dried at the station by warm air supplied through pipes, and the rims by warm air supplied to rotary devices, each comprising a central pipe, having an outlet and a branch pipe, with an outlet, to direct air against the inside and outside of the rim. The air passes through a compartment, in which is arranged an electrical heater, and the devices are rotated by a belt. (*J.S.G.T.*)

Frosting glass. M. Pipkin. Brit. 271,097, May 12, 1927. In apparatus for frosting by etching the inside surfaces of electric lamp bulbs and similar glass articles, a bulb is supported over a pipe, extending upwards from a vessel containing strong etching-fluid, which is forced into the bulb by compressed air admitted by a pipe, surplus fluid returning to the vessel through a funnel and pipe. The fluid is kept at a suitable temperature by water circulated in a jacket. After being frosted, the bulb

is washed out by supporting it over a water pipe and the washed bulb is then subjected to a strengthening treatment consisting in applying weak etching-fluid by an apparatus similar to that described above. A number of bulbs may be treated simultaneously, the bulbs being supported in holes in a table having legs which at each station, rest on stops so arranged that the bulbs are over a series of nozzles, the table being raised and run along from one station to the next on rails. In a modified construction of the vessel, this is divided into two compartments by a horizontal partition, fresh etching-fluid being stored in the upper compartment and supplied, when required, through a hand-controlled valve to the lower compartment to maintain the fluid in use at a uniform strength. (*J.S.G.T.*)

Reinforced glass. Corning Glass Works. Brit. 280,196, Dec. 31, 1927. Reinforced transparent sheets suitable for windows of automobiles are made by uniting sheet glass to opposite faces of a transparent strengthening material having approximately the same refractive index as the glass. Pyralin is stated to be a suitable strengthening material for use with lime tank glass. When formed the compound sheet is polished.

Glass manufacture. Naamlooze Vennootschap Mij. Tot Beheer en Exploit van Octrooien. Brit. 280,533, Jan. 11, 1928. Apparatus for forming plate or sheet glass comprises a receiving roll and a sizing roll which together form the sheet, a wall located above the receiving roll, and a pot which is movable about an axis situated close to the upper edge of the wall and to the forward edge of the pot. In operation, the pot is brought up to the wall and is tilted slowly about the axis so that the contained metal slides on to the receiving roll without excessive lapping and folding.

Glass manufacture. Soc. Anon. des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny et Cirey. Brit. 280,582, Jan. 11, 1928. Relates to the method of making sheet glass in which a stream of metal, issuing from a horizontal slot in the wall of a tank or forehearth, flows into the pass between parallel rollers, and is formed into a continuous strip. According to the invention, the glass in the forehearth where it flows through the slot is maintained at a temperature above that at which devitrification is liable to occur, and the issuing glass is cooled rapidly, by more or less prolonged contact with the air and with walls which are more or less conducting, in order to reduce its temperature to a degree suitable for the rolling operation. This cooling is preferably effected by causing the issuing metal to pass into an exterior reservoir formed by a floor slab and side walls.

Glass manufacture. British Hartford-Fairmont Syndicate, Ltd. and T. Wardley. Brit. 280,611, Jan. 11, 1928. Apparatus for feeding molten glass from a receptacle through a discharge opening comprises means for moving the glass positively in a plane substantially at right angles to the axis of the discharge opening in order to keep the glass of uniform temperature and consistency.

Glass manufacture; ceramic stone. Patent-Treuhand-Ges. für Elektrische Glühlampen. Brit. 281,249, Jan. 18, 1928. A ceramic material which is fusible at reasonable temperatures is made by melting siliceous rock, such as phonolith or its decomposition products, with fluorspar or other fluorine-containing material in a quantity equal to, or exceeding, 20% of the mixture. A suitable mixture consists of 100 parts by weight of phonolith with 50 parts by weight of fluorspar. If the alumina content of the material is insufficient, additional alumina, or clay or kaolin, may be added. The alumina facilitates devitrification and enables a finished product to be obtained which resembles porcelain. Alkali may also be added to the materials, and the melting operation may be prolonged if a finished material of more glasslike character is required.

Severing glass. B. L. GREGG. Brit. 281,324, Jan. 25, 1928. A method of cutting sheet glass along a desired line of cleavage consists in heating the glass along the line and also heating, to a lesser degree, the areas of glass adjacent to the line. Apparatus for carrying out the method comprises an electrically heated wire extending below the desired line of cleavage in association with heating plates, and a movable supporting frame arranged to raise or lower the heating plates and the wire into or out of proximity to the glass.

Glass manufacture. C. H. RANKIN AND RANKIN AUTOMATIC GLASS FEEDER CO., LTD. Brit. 281,382, Jan. 25, 1928. A method of delivering a charge of molten glass to a mold consists in feeding the severed charge to the open lower end of a mold, and propelling the charge upward into the mold by means of compressed air.

Glass manufacture. T. C. MOORSHEAD. Brit. 281,383, Jan. 25, 1928. In a machine of the press-and-blow type for making glassware, each blank mold receives a gob or charge of metal while it is in continuous movement past a feeder, and the charged mold is then moved inward into coöperation with a ring mold. After a charge has been pressed to form a parison, the blank mold opens and is moved outward again, leaving the parison suspended from the ring mold until it is enclosed by the finishing mold and blown.

Heavy Clay Products

The development of a kiln for firing sewer pipe. E. F. CLEMENS. *Jour. Amer. Ceram. Soc.*, **11** [3], 131–36 (1928).—Full description is given of a kiln for firing sewer pipe, with dimensions and innovations which have proven best. The use of smaller fire boxes tends to prevent overfiring, to give hotter and more complete combustion, and to prevent roughness.

Experiments with stoker firing. E. F. THEOBALD. *Jour. Amer. Ceram. Soc.*, **11** [3], 137–42 (1928).—The use of stokers on a downdraft kiln is discussed. Results of several firings are given, changes being made to correct defects observed. Difficulties encountered and advantages noted are listed.

Fire-travel in continuous kilns. ALFRED B. SEARLE. *Jour. Amer. Ceram. Soc.*, **11** [3], 143–56 (1928).—A general comparison of tunnel kilns and other continuous kilns is made taking up such questions as size, condition of the brick entering the kiln, draft, and rate of firing. As this is based on European practice, discussions based on American practice are appended.

A study of underground clay mining. H. E. NOLD. *Jour. Amer. Ceram. Soc.*, **11** [3], 157–68 (1928).—The conditions in underground clay mining as noted during a survey of the heavy clay industries of Ohio are discussed. The need for greater study of the subject is stressed, especially the haulage, drainage, timbering, panel development, and pillar drawing phases. The solution suggested is a mine as carefully planned and operated as the manufacturing plant in order to increase the percentage of recovery and reduce the cost per ton.

Practical mining principles which are frequently overlooked. E. D. OTSTOT. *Jour. Amer. Ceram. Soc.*, **11** [3], 169–72 (1928).—Practical problems of drainage, timbering, haulage, and loading in clay mines are discussed. Suggestions are given for saving time, labor, and expense.

Blasting practices in clay mines. C. H. COALE. *Jour. Amer. Ceram. Soc.*, **11** [3], 173–80 (1928).—Blasting materials and methods are described and detail discussion given on the comparative effectiveness of the various explosives under the several conditions met with in clay mining. U. S. Bur. Mines *Circ.*, No. 6051, on permissible explosives by C. E. Monroe is appended.

Recent progress in electrical application for the heavy clay industry. T. B. HUESTIS. *Jour. Amer. Ceram. Soc.*, **11** [3], 181–91 (1928).—The advantages, proved in installations, of electric drives and controls are recited and detailed descriptions are given of the

manner and advantages of electric drive and control of the several machines and means of moving the clay and ware in the heavy clay products plants. The paper is illustrated by photographs of installations which have been found successful.

Bond between concrete and hollow tile. ANON. *Rock Prod.*, **31** [2], 117 (1928).—An investigation of the bond between concrete and hollow tile has just been completed. The factors covered by the tests included 6 different types of hollow tile and concrete mixtures of several consistencies and proportions. The tile used in making the specimens were in a dry, saturated, or in a semisaturated condition. The specimens were cured either in dry or in damp storage. All specimens were tested when 28 days old, the damp-storage specimens being allowed to dry out 14 days prior to testing. Concrete control cylinders 6 x 12 in. were made from the same batches as the concrete in each bond specimen. The test specimens represented sections from a hollow-tile concrete floor, each made up of two tiles joined by a concrete block 4 in. in thickness. The testing consisted in loading the concrete blocks by a heavy bearing block, the tile forming the lower base. The object was to obtain a shearing failure between the concrete. The results obtained indicate that the bond depends largely on the strength of the concrete, but this relation may be disturbed by using saturated tile or damp curing. The condition least favorable to a good bond was found to exist when specimens were made from saturated tile and then cured damp. This particular tile had an absorption of about 10%. In general, damp curing did not increase the bond strength. Specific factors which affected the bond strength were (1) strength of the concrete (the stronger the concrete the greater the bond); (2) absorption of the tile (no general law being observable); (3) amount of water in the tile (the greatest bond being developed by dry tile, slightly less sprinkled tile, and the least bond by saturated tile); for tile of the lowest absorption, about 3.1%, there was no material strength difference in bond, whereas the greatest bond difference was recorded for the tile with 5% absorption. The absorption ranged up to 21%; (4) curing conditions: the dry-cured specimens developed a slightly higher average strength than the damp-cured. As a practical guide in construction, based on the results of these tests, it is recommended that the hollow tile be sprinkled only enough to work off the dust and loose particles, and that concrete contain the minimum amount of mixing water necessary for proper placement. F.P.H.

Rock-lime brick plant at Steinag. ANON. *Tonind. Ztg.*, **80**, 1461 (1927); *Rock Prod.*, **31** [2], 96 (1928).—As good brick clay is abundant in Austria, the rock-lime brick plant Steinag in Gross-Schwechat near Vienna was first looked upon as an unwelcome intruder. The war, however, brought about improvements for the plant. In 1923, the Vienna municipality purchased an interest in the plant, thus insuring its future. The plant was built in 1912 by the Rohrig and Konig Co. (Magdeburg) with a capacity of 50,000 brick standard Austrian dimensions per 10 hours. It was equipped with 4 Rohrig and Konig presses and 4 hardening cylinders. A 5th press and an additional hardening cylinder were installed and a 2-shift operation introduced when the plant faced the responsibility of supplying the city of Vienna. Most of the sand-lime brick produced is used in Vienna, where they enter all forms of construction. Paving units for street-car tracks are also manufactured in the plant. They are cheaper than concrete paving units and are used exclusively in the city of Vienna. In 1925 the company produced 20,000,000 sand-lime brick, 45,000 m. stairs, 35,000 m. pipe, 15,203 sq. m. slabs, and 2000 grave stones. The last are cement products manufactured in the plant, which is now considering further extensions. F.P.H.

Brick. Report of Committee C3. ANON. A.S.T.M. Comm. Reports, Part I, 313–15 (1927).—Committee C3 offers the following recommendations for use when reprinting specifications for building brick: (1) that the standard specifications for building brick (C21–20) be withdrawn; (2) that the proposed specifications for building brick (clay or shale) as appended be accepted as tentative; (3) that the proposed specifi-

cation for paving brick, appended, be accepted as a standard revision of the present specifications. (4) That the proposed method of testing brick, appended, be accepted as tentative. The definition for "brick" is given as tentative. R.A.H.

Poisson's ratio and the modulus of elasticity of sand-lime brick. ANON. Bur. Stand., *Tech. News Bull.*, No. 129, p. 6 (1928).—Data are given on 12 sand-lime bricks which were tested for stress-strain relationships. The secant modulus of elasticity for bricks tested on end had an average value of about 1,700,000 lbs./in.^{2} at no load to about 1,600,000 at a stress of 1000 lbs./in.^{2}. The modulus of elasticity in compression was about equal to the modulus in tension. Both longitudinal and transverse strains were determined. R.A.H.

Making the world's hardest soft-mud brick. ANON. *Brick Clay Rec.*, **71** [13], 926–29 (1927).—A historical sketch of the Densmore Brick Co., of Lebanon, N. H., is given, tracing its existence from 1817. From 1817–1881 the product was only water-struck brick, but in 1887 a sand-struck machine was installed and 4 years later a soft-mud brick machine was installed. At present 2 yards are making water-struck brick, each with a capacity of 12,000 brick, while the machine making sand-struck brick has a capacity of about 50,000 brick per day. The company is said to produce the hardest brick from a surface clay of any plant in the country, having to its credit 2 world's records resulting from tests made at the Case School of Applied Science at Cleveland, Ohio. Compression tests on 3 different samples of the company's hard brick ran between 17,000 and 18,000 pounds per sq. in., and it is conservatively estimated that more than 60% of all the brick fired will test over 8,000 pounds per sq. in. in compression. When considered that all the brick are made from a surface clay and fired in updraft scove kilns, this is a remarkable figure. Details of plant equipment and manufacturing processes are given. E.J.V.

Adhesion of plaster and stucco to hollow tile by scoring. J. A. MURRAY AND H. D. FOSTER. *Brick Clay Rec.*, **72** [1], 34–35 (1928).—Tests of the adhesion of gypsum, cement, or cement-lime to representative samples of three standard grades of clay tile: hard, medium, and soft, with both combed and grooved scoring, as well as to samples of medium tile with "wire cut," "smooth," and "salt glazed" surfaces were made. The details of the process used and results obtained are enumerated. E.J.V.

Progress at Columbia Brick Works. A. E. V. DUNN. *Brick Clay Rec.*, **72** [2], 104–106 (1928).—A historical sketch of the Columbia Brick Works, at Portland, Ore., which has been continually improving its methods of manufacture and adding new equipment. A kiln utilizing the fuel economies of the continuous kiln and adding to it the labor-saving advantages of the compartment type of kiln, developed by the founder of the company, is used. An automatic coal stoker is used for firing. An electric shovel and electric locomotive are used for digging and hauling the clay used. E.J.V.

Factory design and equipment. XI. T. W. GARVE. *Clay-Worker*, **89** [1], 28–32 (1928).—A continuation of the discussion of various processes used in the production of ceramic ware. The stiff-mud process of manufacturing brick and tile is described in considerable detail. Types of machines used in this process are discussed. The history of rough texture stiff-mud brick and wire-cut texture brick is traced. The fault of lamination associated with the stiff-mud process is discussed. The production of sewer pipe in presses is described. The dry-press process is explained in detail, as are wet processes, used in the preparation of synthetic clays or clay bodies for the manufacture of pottery, sanitary ware, and fine ceramics. **XII.** *Ibid.*, **89** [2], 127–31 (1928).—Automatic handling of materials is the general topic taken up. The difficulties encountered in handling clays are mentioned. Vehicles used in handling clays or mixtures (hand trucks, power trucks, narrow gage railways with various types of car and power equipment, and overhead monorail systems) are discussed. For elevation of material

the bucket elevator, skip hoist, and platform elevator are used. The bucket elevator gives most trouble. A detailed discussion and description of set-ups of bucket elevators is given, pointing out various advantageous features in each. A skip hoist and platform elevator are described briefly. For previous abstracts of this series see *Ceram. Abs.*, **7** [3], 167 (1928). E.J.V.

The evolution of brick and brickmaking in the U.S. V. GEORGE M. FISKE. *Clay-Worker*, **89** [1], 36–38 (1928).—A continuation of the history of the development of the Chambers machine for production of brick. Difficulties encountered in having the machine accepted by the trade are recounted. A paper by E. E. Frey on the subject, "When and Where Were the First Brick Made by Machinery?", read at the N.B.M.A. meeting in 1906, is given in abstract form. **VI.** *Ibid.*, **89** [2], 132–34 (1928).—The brickmaking machinery patented in the initial period of 1830 to 1864 is discussed. Beside the Penfield and Chambers machines there was perfected by Henry Martin (who incorporated the Henry Martin Brick Machine Mfg. Co., at Lancaster, Pa.) a soft-mud machine. The concern he founded is now the Lancaster Iron Works, Inc., managed by his son and still making his machines and improvements thereof. Another clay-working machine invented and installed in this period is the Stevenson System, invented by the founder of the Stevenson Co., of Wellsville, O. These machines are described. For previous articles see *Ceram. Abs.*, **6** [11], 517 (1927). E.J.V.

New clay plant ideas. H. R. STRAIGHT. *Clay-Worker*, **89** [1], 75 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **10** [5], 367–72 (1927); see also *Ceram. Abs.*, **6** [7], 282; [11], 517 (1927). E.J.V.

Model of world's largest brick plant. ANON. *Clay-Worker*, **89** [2], 116–17 (1928).—A description of the model brick plant, reproducing to a scale of $12^1/_2$ feet to the inch the Illinois Brick Co.'s plant No. 22, which is producing 700,000 common brick daily. The model was built by Valerie Legault and is on permanent exhibit in the Field Museum, Chicago. E.J.V.

New plants in Quebec Province. ANON. *Mfg. in Canada*, **4** [12], 39 (1927).—The Citadel Brick Co. has let a contract for building a new plant at L'Islet for the manufacture of hollow ware, similar to the system used on the Quebec plant. The Lennoxville Brick and Tile Co., Quebec, has been incorporated ($200,000) to manufacture and deal in brick, tile, marble, cement, etc. The Ceramic Products Co., Montreal, has been incorporated ($99,000) to manufacture and deal in ordinary and decorative tile. H.H.S.

Progress with sand-lime brick. ANON. *London Monthly Market Rept.*, **6**, 268–70 (1927).—The sand-lime, or calcium silicate, process introduced in 1894 is now making rapid progress in Britain. The largest firms using it are Sutcliffe Speakman of Leigh, the Mansfield Sand Co. of Nottingham, and the Standard Sand Co. of Nottingham. The total plant can put out 1,250,000 brick a day. The process consists in mixing sand with 5–10% of slaked lime, together with a small amount of water. The plastic mass is passed through a continuous brick press, and the shapes are heated in an autoclave for 4–8 hrs. by blowing in steam at 120–180 lbs. pressure. Calcium silicate is formed and the result is a smooth and intensely hard brick, like natural building stone. H.H.S.

PATENTS

Molding bricks, etc. D. G. MACKENZIE. Brit. 281,346, Jan. 25, 1928. Machine for molding brick, tile, road sets, etc., comprises a common shaft supporting an inter-intermittingly-rotated member carrying fixed mold bottoms and radially-sliding mold frames, and a second oscillatory member which drives the first member and operates the sliding mold frames; and a ram coöperating with the slidable mold frames.

Brick presses. H. ACKERMANN AND SCHEIDHAUER AND GIESSING AKT.-GES. Brit. 281,593, Jan. 25, 1928. In the machines for pressing bricks, the cheeks of the molding-box which define the length of the brick are mounted adjustably in the press table in addition to the cheeks which define the width of the brick.

Refractories

Winning of Missouri diaspore, burley, and flint clays. C. R. FORBES. *Jour. Amer. Ceram. Soc.*, **11** [3], 204–14 (1928).—The process of mining Missouri diaspore, burley, and flint clays is described in careful detail.

Refractories. (Report of Committee C8.) ANON. A.S.T.M. Comm. Rept., Part I, pp. 330–35 (1927).—Revisions are recommended in (1) the standard method of test for softening point of fireclay brick with reference to angle of mounting of cone and the rate of heating and (2) in the standard method of test for resistance of fireclay brick to spalling action with reference to percentage of material spalling from brick. R.A.H.

History of the refractories industry. W. STEGER. *Sprechsaal*, **60** [52], 1005–10 (1927).—A short review of the early literature on this industry, the progress in the manufacture of refractory products, and the development of consumer industries in the past 60 years. Preparation and shaping, drying and firing, and investigation of the properties of refractories are discussed. Use of refractories in iron and steel and other metallurgical industries, coking ovens, gas works, cement, lime, glass industries, and boiler settings are reviewed. R.A.H.

Open-hearth steel works refractories. A. T. GREEN. *Foundry Trade Jour.*, **37** [583], 50–52 (1927).—There is considerable variation in the constitution and physical properties of silica brick and an investigation of the classes of products used in open-hearth furnaces shows that many different varieties are used apparently with equal success. Silica brick used in the steel industry are of a coarser texture. Resistance to spalling is required. Coarse-grained materials resist spalling better than fine-grained. W. J. Rees suggests the addition of 2% finely divided ferric oxide to increase the strength. The final porosity should not exceed 27%. Angularity of the fragments, particularly, promotes higher mechanical strength. The constitution of silica products is mainly determined by (1) nature of the raw materials, (2) the manufacturing procedure, especially the grading of the raw material and nature and amount of flux (which is hydrated lime generally), and (3) the control and extent of firing. Highly converted silica, particularly cristobalite, is unsuitable for open-hearth construction because it enhances spalling at low temperatures. The true specific gravity is in a way a measure of the amount of conversion a silica product has undergone during firing. Highly converted silica brick have a specific gravity of 2.32–2.35 and medium converted varies from 2.42–2.47. The apparent specific gravity of well-fired fireclay products varies from 1.8–2.2. With increasing vitrification the apparent specific gravity is increased. The thermal conductivity of a silica brick is generally superior to a fire brick at high temperatures. The use of Carborundum is not an economical proposition to improve the thermal characteristics because it oxidizes and swells with continued use. G.W.W.

Use of chlorine in the preparation of alumina from clay. T. SUZUKI. *Can. Chem. Met.*, **11** [11], 292 (1927).—A very efficient process for the manufacture of pure alumina from clay or allied substances has been developed. The crushed clay is heated in an electric furnace with coke or wood charcoal, the greater part of the iron and silicon present in the clay, being reduced, form ferrosilicon, which sinks to the bottom of the furnace and can be tapped off. Alumina floats on the top and can easily be separated from the ferrosilicon. This material can not be used directly for the production of

aluminum, because of its low grade of purity, low solubility in cryolite, and the great hardness of the mass which makes it difficult to crush. When the lump of this crude alumina is treated at 200–400°C in a current of chlorine gas, iron and silicon present in the mass as impurities combine with chlorine, the chlorides volatilize off and can be collected as by-products. The mass of alumina thus purified is very pure, can be easily reduced into powdery form, and is soluble in cryolite. Although the possibility of getting alumina of quality by this process is apparent, the amount of consumed electrical energy and cost of chlorine must be considered. E.J.V.

Effect of steam on the transverse strength of fireclay brick. C. W. PARMELEE AND A. E. R. WESTMAN. *Clay-Worker*, **89** [1], 41–43 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **10** [4], 292–98 (1927); see also *Ceram. Abs.*, **6** [6], 223 (1927). E.J.V.

Refractories in power plants. R. A. SHERMAN. Amer. Refrac. Inst., *Tech. Bull.*, No. 18 (1927).—Twenty per cent of the fireclay refractories manufactured is used in boiler furnaces, a larger percentage than in any other type of furnace except open-hearth steel furnaces, where 34% of the total production is used. This paper covers (1) the reason for "boiler built around the furnace," (2) its significance to the refractories industry, and (3) the future status of refractories in power plants. Reducing the cost of generating steam has resulted from (1) more efficient use of coal, (2) lower grades of fuel, and (3) reduction of investment costs per unit of output. Although the improvements in fuel-burning equipment, boilers and accessories have kept pace with the increased severity of service which results from more efficient combustion, higher ratings, and the use of lower grades of fuel, refractories have not, and the excessive cost of repairs and outage due to their failure often limits the efficiency and rating which could otherwise be obtained. When power-plant engineers found that the refractories commercially available would not withstand the extreme conditions of service, they demanded improved refractories that would; and when these were not forthcoming they adopted methods to lessen the severity of conditions without decrease in efficiency. Air cooling was first tried, the air being used for combustion; it is successful under moderate conditions but is limited in application because the thickness of wall between the flame and the air necessary for strength and the low thermal conductivity of fireclay brick result in a low rate of heat transfer. The next development was the protection or replacement of the refractories in the most severely affected areas by water- or steam-cooled surfaces which formed part of the circulating system of the boiler. These were successful, and because the rate and efficiency of heat transfer to the water or steam are high they have been extended to other parts of the furnace. In many furnaces refractories have been entirely eliminated. The development of water-cooled furnaces has progressed with increasing rapidity during the last three years. The 1927 report of the Prime Movers Committee of the National Electric Light Assn. shows that some type of water-cooled walls is in use or being tried by 70% of the member companies which reported. The initial cost of water-cooled walls is generally greater than that of firebrick settings; therefore their use is limited by the increased investment necessary to secure high efficiencies. Further, they can only be used with pure water because of the danger of tube failure due to the increased rate of scale formation at the high rates of heat transfer. The refractories service conditions in small boiler plants are not ordinarily extremely severe. There is a real demand, however, for better service from their refractories. The use of plastic refractories is increasing in these plants because of lower labor cost for installation. Their future status in power plants largely depends on the maintenance of their position in the plants of moderate size. There are 2 principal lines of progress open to manufacturers of refractories: (1) the improvement of this product, and (2) the proper application of the present product. There is probably more hope for progress in the proper application of the present product. Definite knowledge of the capabilities and limitation of refractories has been hampered in the

past by the lack of definite information on the conditions of service, and on the mechanism of failure of refractories. During the past 3½ years the U. S. Bureau of Mines in coöperation with the A.S.M.E. has conducted a field investigation of all the factors which might govern the life of refractories both qualitatively and quantitatively and many data have been supplied. The mechanism of the failure of refractories is being studied under the same coöperation by the U. S. Bureau of Standards and the Univ. of Illinois. The specific problems are (1) a study of the 4-component system: alumina, silica, lime, and iron; (2) a study of the viscosities of boiler-furnace slags; (3) the microscopic examination of the slagged and spalled specimens collected in the field investigation; and (4) a study, in a special slagging furnace, of the factors governing slagging. The adoption of water-cooled walls for furnaces in those power plants in which the conditions of service exceeded the inherent limitations of refractories should benefit rather than harm the refractories industry. F.P.H.

By-product coke and gas industry. C. J. RAMSBURY. *Blast Fur. Steel Plant*, **16** [1], 28–29 (1928).—R. states that heating ovens with blast-furnace gas becomes a feature of operation which will undoubtedly find extensive use. In Germany the use of blast-furnace gas in oven heating has been in use for a long time with marked success. The limitation of sulphur in gas is very advantageous. F.P.H.

Open-hearth improvements. C. W. VEACH. *Blast Fur. Steel Plant*, **16** [1], 34–36 (1928).—This is a summary of the modifications in practice and furnace design which have been established during the past year as viewed by a steel maker. An attempt is being made by one ceramic corporation to substitute chrome brick for magnesite brick in the lining of basic open-hearth furnaces. Besides advocating chrome brick for the bottom of the hearth, this company is experimenting with chrome with the idea of developing a brick that will stand up in the side walls and ends of the furnace, and to be used as linings in the downtakes as it is thought that chrome will withstand the abrasive action of the solids, carried over in the waste gases, better than silica. The difficulty to be overcome is the tendency of chrome brick to crumble under high heat, but if this tendency can be overcome improvement will result, because chrome is less subject to attack by slag particles than silica or magnesite. F.P.H.

History of the refractories industry. J. D. RAMSAY. *Blast Fur. Steel Plant*, **16** [1], 38–40 (1928).—R. traces the development of the refractories industry in the U. S. The records indicate that it originated along the Raritan River in N. J. in 1825. Today some 5 or 6 counties of western Pa. produce probably ⅔ of all the refractories made in the U. S. Statistics on the production of refractories in this country over the period 1870–1926 are given. The efforts made at various times to improve the product are traced. The value of research in this field is stressed. The need for closer coöperation between consumer and producer is pointed out. F.P.H.

Refractory materials. A. T. GREEN. *Blast Fur. Steel Plant*, **16** [1], 79–80 (1928).—This paper is of a general and introductory character for nontechnical readers, and so constitutes an extremely useful review of the whole subject, emphasizing the work already done and the direction in which work still remains to be done. The necessity for ascertaining the effect of actual industrial conditions upon the life and performance of refractory materials is pointed out. In other words, there is a need for an adequate definition of working conditions. F.P.H.

Silicon-carbide muffles save fuel. ANON. *Ceram. Ind.*, **10** [2], 165 (1928).—The problem of determining the most efficient refractory for use in glass annealing leers is reported to have been satisfactorily and economically decided at the Muncie, Ind., plant of Ball Brothers by the installation of silicon-carbide muffles in all of the jar lid leers. Prior to this change, clay muffles were used, and the usual difficulties of non-uniform heat distribution were encountered, which were due to low heat conductivity, and were indicated by over-heated sides. With this there was the accompanying loss

of ware at this point, due to sagging and cold sections through the middle of the carrier, which caused cracking and breakage. In the operation of the leers with fireclay muffles it was found necessary to use burners below the carrier, in order to heat it to a proper temperature to receive the ware. This was entirely eliminated after the change in muffle material was made. In the lid leer, a special design of silicon carbide corrugated muffle arch tile was used to give greater radiating surface, and of a size to span the leer. A saving of 30% fuel has been noted. F.P.H.

Requirements of refractory material used in manufacturing molded plate glass and wire glass. JULIUS LAMORT. *Feuerfest*, **3** [9], 141–45 (1927).—The requirements of refractory material used in making glass pots, arches, burners, hearths, and door arches are discussed. The temperatures that these various parts of the furnaces are required to withstand are given. Pots used in making molded plate glass are usually composed of 50% bond clay of 23–26% alumina (calculated on the air-dry basis), 25% fired lean clay, and 25% pot grog. Diagrams of European glass-tank furnaces and glass-pot furnaces are given. The highest quality of refractory material is used in the manufacturing of molded plate glass. F.P.H.

A study of cupola-lining refractories. W. T. SCHALLER. *Foundry Trade Jour.*, **35**, 567 (1927); *Feuerungstechnik*, **15** [24], 288 (1927). F.P.H.

Historical development of the by-product coke oven. MOTT. *Fuel*, **6** [8], 373 (1927); *Feuerungstechnik*, **15** [25], 299 (1927). F.P.H.

Genesis of Grecian magnesite. J. R. THOENEN. *Min. and Met.*, **9** [254], 79 (1928). —The consensus of opinion in the published literature on Grecian magnesite is that it has been formed by alteration of the serpentine, which in turn was itself a product of metamorphism from the original olivine intrusion. The general opinion seems to be that the magnesite was formed by descending waters heavily charged with CO_2, but alteration of serpentine by water does not satisfactorily explain the flow structure noted on Lefko Island. T. claims no expert knowledge of geology or of the genesis of ores. His observations on the location, topography, and geology of the deposits are offered in an attempt to provoke discussion and with the hope that they may throw some further light on the source of the Grecian deposits. F.P.H.

Geological features of the magnesite deposits of Washington. S. S. SIEGFUS. *Rock Prod.*, **31** [2], 92 (1928).—Although attention has been called to their importance as early as 1902, it was not until 1916 that the development of the deposits as a source of magnesite for refractory purposes was begun. Magnesite found in Washington is of coarse crystalline texture, occurring as massive beaded deposits of dolomite. The color is generally light gray, although considerable amounts are reddish brown. The variation in color and texture indicate the varying proportions of lime and silica, the chief impurities. There are no hardfast rules for recognizing the quality of the rock by sight; sampling and comparison with type samples are the means generally used. F.P.H.

Refractory brick "cut on the bias." ANON. *Min. and Met.*, **9** [254], 98 (1928).—A stronger wall in firebrick construction has been obtained, according to the manufacturers, by the development of "Biasbrix," a new product of General Refractories Co. As the name implies, it is a unique shaped refractory. In construction Biasbrix are laid on the bias, one brick overlapping and tying together three other Biasbrix in a natural self-locking construction which gives exceptionally tight joints and a wall of great strength. On account of this peculiar construction and interlocking feature, it is claimed that walls so constructed do not loosen up, joints remain tight, and heat losses and slag penetration are reduced to the minimum. While Biasbrix are different in shape, they lay up quite as readily as the ordinary straight brick in any thickness of wall from $4^1/_2$–27 in. or more, and are equally well adapted to large or small installations. Particular emphasis is placed on their worth in hollow-wall construction, where a strong bond is of essential importance. F.P.H.

Suspended-roof furnaces. W. A. FORBES. *Amer. Iron Steel Inst.* (Advance Paper, N. Y. Meeting), p. 35(1927).—During the past year or more, several plants of the U. S. Steel Corp. have installed suspended roofs, both of flat and arch types. These roofs are usually made of special silica shapes, hung on their cool side by an exterior support which is vertically carried from channels spanning the furnaces. Expansion and contraction are provided for by compression springs placed between buckstays. The claims made for these furnaces are that there is no danger of the roof caving in on a heat, that spalling of brick may be eliminated, and that hot patches can be made with little difficulty. The results obtained from several plants have been promising. One roof lasted 400 heats, another 360, under severe conditions. Spalling was reduced, but in hot patching no advantage resulted since more than the worn sections were involved by the fusing of the brick. H.H.S.

PATENTS

Replaceable floating bridge part for glass furnaces. WILLIAM K. BROWNLEE. U. S. 1,657,106, Jan. 24, 1928. In a glass furnace having a fixed bridge wall, a floating block of refractory material located in juxtaposed relation to the face of the bridge wall and having a width to prevent movement of the glass over the face of the bridge wall.

Furnace wall. WILLIAM H. BOYD. U. S. 1,657,453, Jan. 31, 1928. In a wall structure, anchoring blocks and means supporting the same in vertically and horizontally spaced relation, and surfacing blocks arranged in stacks and having vertical sliding interlocking engagement with the anchoring blocks and individually removable therefrom by vertical sliding movement to extreme position above the coöperating anchor blocks.

Making refractory products and articles produced thereby. WILLIAM A. FARISH. U. S. 1,658,406, Feb. 7, 1928. A method of making refractory products comprising forming an intimate dry mixture of graphite, and an electric furnace refractory product, then intimately impregnating such dry mixture with a carbonizing binder, forming the product, carbonizing it, and then dipping it into a liquid fluxing agent.

Making zirconium compounds. CHARLES J. KINZIE. U. S. 1,658,807, Feb. 14, 1928. The method of treating a siliceous zirconium ore which comprises heating the ore mixed with an alkali to its substantial decomposition, treating the residue with acid to obtain both zirconium and silicon in acid solution, causing the zirconium compounds to precipitate from the solution while leaving the silicon therein, and removing the silicon-containing solution from the precipitated zirconium.

Producing highly refractory magnesite masses. FELIX BAUMHAUER. U. S. 1,659,476, Feb. 14, 1928. The method of making a refractory, which comprises melting magnesite containing an iron compound as an impurity, and reducing the iron, grinding the product, separating substantially all of the iron, granulating the product and binding the same with finely ground product.

Refractory or acid-proof material. SCHEIDHAUER & GIESSING AKT.-GES. Brit. 263,194, Dec. 19, 1925. Nonplastic materials such as grog, fused Al_2O_3, corundum, carbides, Zr compounds, Cr oxide, MgO, sillimanite or SiO_2 are mixed with an alkaline kaolin slip to form a noncastable mass which is molded and may be used for lining furnaces or for other purposes. (*C. A.*)

Quartz working. E. R. BERRY. U. S. 1,620,511, March 8, 1927. In making quartz tube or cane, the extruded plastic mass is allowed to pass downward into a deep vertical chamber. In one form of apparatus, this is filled with a heavy liquid such as sulphuric acid or suitable organic liquid of density 1.5–2.2, according to the size of the extruded material, and in another, the end of the cane or tube rests on a platform carried by an endless belt in such a way that, as the platform descends, more and more links of heavy chain are raised by the ascending side of the belt. In both forms, the increasing

weight of the extruded section is counterpoised and the tendency to reduce the cross-sectional area at the extrusion orifice avoided. (*J.S.G.T.*)

Refractory substances. R. HADDAN. Brit. 265,847, June 25, 1926. Refractory articles composed of crystals embedded in a glassy matrix are obtained by fusing suitable substances, *e.g.*, mixtures of kaolin with diaspore clay or bauxite, casting, and annealing. The materials are fused in an electric furnace and cast in iron or sand molds. Three methods of annealing are described. (*T.E.C.S.*)

Porous refractory articles. CARBORUNDUM CO., LTD. Brit. 266,165, April 9, 1926. A clay substantially free from fluxes, such as a kaolin having two molecules of silica to one of alumina, is converted into a slip, mixed with half its weight of wood flour, and fired. The resulting porous grog is crushed, mixed with more kaolin and wood flour, molded, and refired. (*T.E.C.S.*)

Refractory articles. HARTFORD-EMPIRE CO. Brit. 266,751, Feb. 28, 1927. A mixture of 4 parts of raw aluminium hydrate (diaspore or bauxite), 4 parts of calcined aluminium hydrate, 2 parts of commercial calcined alumina, 3 parts of raw grossalmerode clay, with or without 5 parts of a plastic clay to act as binder, is ground to pass a 325-mesh, made into a slip with water and agitated at about 90°, screened, filter-pressed, and dried. One portion of the dried material is converted into grog by calcination at 1750° and crushed to pass a 12-mesh. The other is reground to 325-mesh, 20% of water is added, the mixture is pugged, partly dried, and molded under pressure. The pressed blocks are fired at 1730°. (*T.E.C.S.*)

Furnace crowns; bricks and shapes. E. STRUNK. Brit. 267,444, Dec. 1, 1926. Furnace roofs are built up of two rows of bricks, the lower row being supported by the bricks of the upper row, which are suspended from girders. The bricks are dove-tailed. (*T.E.C.S.*)

Regenerator bricks. O. STRACK AND PFÄLZISCHE CHAMOTTE U. THONWAREN A.-G. Brit. 268,431, Mar. 21, 1927. Columns are formed of refractory blocks similar in external shape and having vertical passages increasing in number from the uppermost to the lowest layers. The total cross-sectional area of the passages and the amount of refractory material in each of the blocks are substantially the same. (*T.E.C.S.*)

Bricks for glass furnaces. HARTFORD-EMPIRE CO. Brit. 269,153, March 22, 1927. Blocks for lining glass tanks have interlocking corrugations, which form tortuous joints in the lining, so that glass entering a joint is compelled to move in a different direction before penetrating a considerable distance into the block. The surface in contact with the glass is plane. (*T.E.C.S.*)

Fused silica. W. CARPMAEL. Brit. 280,291, Dec. 31, 1927. Relates to a method of producing hollow bodies of quartz, or similar material, in which the hollow space is closed at one end. According to the invention, the quartz is fused by a tubular electric resistor which has one end closed, one of the supply leads being connected to the open end while the other is connected to a stem leading to the closed end. Instead of being tubular, the resistor may be in the form of a helix.

Refractory substances. DEUTSCHE GASGLÜHLICHT-AUER-GES. Brit. 280,907, Jan. 18, 1928. A method of making articles of refractory materials such as oxides of zirconium, of thorium, or of the rare earths, consists in heating mixtures of sintered and nonsintered materials as rapidly as possible to temperatures of 1300°C and above.

Porous refractory bricks. I. SETTERBERG. Brit. 281,254, Jan. 18, 1928. Porous refractory bricks are made by adding to finely-divided refractory material a substance capable of evolving gases by reacting with water, such as powdered aluminium, zinc, calcium, or calcium carbide, adding water to form a dough, allowing the mass to rise and then drying and firing. When metal powder is used, a suitable amount of alkali, lime, or other basic material is added to facilitate the reaction. Suitable refractory

materials are refractory clay, chamotte, kaolin, quartz, quartzite, flint, magnesite, dolomite, ferrochrome, and alundum.

Treating zirconium ores. RHENANIA-KUNHEIM VEREIN CHEMISCHER FABRIKEN AKT.-GES. Brit. 282,023, Feb. 1, 1928. Zirconium ores are admixed with an alkaline earth carbonate, oxide, or hydroxide, and with a halogenide of an alkali or alkaline earth metal and subjected to a sintering process at approximately 1200°C in the absence of carbon or carbides, preferably in a reverberatory furnace such as a revolving furnace. Zirconium oxide, soluble in acids, is thereby produced. The presence of steam, which may be supplied as such or be produced by the combustion of fuels rich in hydrogen is advantageous, since it allows lower temperatures to be employed. According to examples, a mixture of ore, fluorspar, and calcium carbonate is finely ground and heated to 1200°C, and a ground mixture of ore and calcium carbonate is moistened with calcium chloride lye and calcined at 1250°C.

Terra Cotta

History of stoneware. W. PUKALL. *Sprechsaal*, **60** [52], 994–96 (1927).—A short review of the developments in the industry in the past 60 years. R.A.H.

Manufacture of refractory tile stoves. E. AND H. KILLIAS. *Keram. Rund.*, **35**, 801–804, 825–28, 843–46, 877–78 (1927).—For the production of refractory ceramic-tile stoves (for domestic use) a light-colored plastic high-melting clay containing very little lime is generally used. The ratio of Al_2O_3 to SiO_2 may vary between rather wide limits but the content of Fe_2O_3, CaO, MgO, Na_2O, and K_2O must be small. The chemical or rational analysis alone is generally of little value for determining the usefulness of a clay for this purpose. Other tests which should be used are (*a*) the nature of the coarse-grained impurities such as lime nodules, pyrite, and quartz grains; (b) determination of the bonding power by admixtures of grog (up to 2 mm. in size) until customary plasticity is reached, the bonding power being expressed in the required percentage amounts of added grog; (*c*) shrinkage measurements including drying shrinkage, firing shrinkage at cones 011, 010, 05, and 1, and total shrinkage at the customary firing temperature; (*d*) determination of the necessary amount of mixing water (water of plasticity) in terms of per cent of dried clay; (*e*) the color of the clay fired at the usual plant temperature; (*f*) the porosity of the clay alone as well as with admixtures of grog at the customary firing temperature and at 2 cones above that temperature; (*g*) interaction between body and glaze, the production of crazing, etc., at different firing temperatures. Lime in the clay in large amounts or in large grains is usually very detrimental. The use of grog serves to lower the plasticity and consequently to decrease the shrinkage and the distortion of the body during drying and firing and to increase resistance to sharp temperature changes. Fire clay (fired), saggers, and broken stove tile ground and screened to eliminate grains larger than 2 mm. are used for grog. Grogs must have high preliminary firing (cones 7–16), light color after firing, freedom from impurities such as slag particles, and freedom from soluble salts. Quartz may be used as a grog but it should be fairly free from iron oxide and grains larger than 1 mm. diameter should not be used since they are likely to crack the ware during firing. Detailed instructions and formulas for the production of white, ivory, and colored glazes are given. Raw glazes compounded of PbO, Al_2O_3, and quartz are always yellow and unsuited for white and ivory unless the PbO is partially replaced by K_2O, Na_2O, the alkaline earths, or ZnO. To avoid crazing the introduction of boric acid as frit is sometimes useful since it tends to lower the thermal expansion and increase the elasticity of the glaze although it frequently lowers the tensile strength. Directions are given for the production of opaque and semiopaque glazes. The usual opacifying agents, SnO_2, ZrO_2, and Sb_2O_3 are suggested. Mat and semimat glazes are produced by MgO, ZnO,

and some of the coloring oxides. ZnO is especially recommended. Directions for under- and over-glaze decoration are given. Precautions to be noted in firing the ware are mentioned. The firing temperature is ordinarily between Seger cones 011 and 05. Types of kilns used in firing such ware are described in detail. H.I.

Research on building materials. DIRECTOR OF BUILDING RESEARCH (Eng.). *Pottery Gaz.*, **53** [608], 288–89 (1928).—Items included in the report are on several subjects of interest to ceramists. I. *Reinforced glass.* A request was made to investigate the causes of failure of reinforced glass, as it was found that the replacement costs of this material in several Government buildings were extremely high. A preliminary report on the cause of failure has been made. II. *Utilization of china clay waste.* In the preparation of china clay large amounts of fairly pure silica sand are produced. Being a waste material, hundreds of thousands of tons have accumulated. It is already used locally for concrete block making, and was examined to ascertain whether it possessed any special advantages which might make it worth while shipping to other parts of the country. It was not found superior to many other supplies of building sand. III. *Terra cotta investigations.* The object of these investigations, undertaken in coöperation with the manufacturers concerned, is to formulate, as rapidly as possible, a series of standard tests for the estimation of the durability of terra cotta. In the absence of a definite science of weathering, it is impossible to do more than consider the contributory causes, correlate the various chemical, physical, and mechanical properties related to the different methods of disintegration, measure all these properties on different samples of terra cotta, and compare the results with the figures given by specimens of known quality. Terra cotta may be compounded of ball clay, fire clay, or red marl, each of which possesses different characteristic features and working properties. Apart from constructional defects, failures of terra cotta may be ascribed to (1) chemical action, (2) moisture expansion, (3) rupture by crystallization, (4) disintegration due to differential expansion of the constituents, (5) thermal spalling, and (6) biological action. Defects in the texture of the body constitute a contributory factor. These defects consist either of laminations in the form of air pockets running parallel to the surface, or of smaller pockets separating the grog grains from the matrix. A detailed study of several of the relatively few weathered terra cotta buildings has revealed the fact that there are two distinct types of weathering, (1) a flaking type, where the material peels off in layers, the chief action being under the surface of the material, and (2) an etching type where the action begins on the surface and shows itself as a general pitting of the whole block. In the great majority of specimens examined, weathering of either type is intimately related to the crystallization of alkali sulphates. The following tests are being carried out: (1) *Microscopic examination.* This has revealed the presence of bad bonding between the grog and matrix in certain cases. Porosity, permeability, absorptivity, and the saturation coefficients of specimens are determined as supplied, and also after freezing and crystallization tests. (2) *Moisture retentivity.* The percentage of absorbed moisture which evaporates per unit surface under standard conditions of temperature and pressure is measured as a guide to the extent to which the material tends to retain moisture. (3) *Specific gravity.* In the absence of any reliable method of measuring pore grading, the variation of the specific gravity of the material in different states of subdivision is being measured. With most specimens a constant value is reached when the material has been broken down to pass through a 200-mesh standard sieve. Tensile, compressive, and shearing strengths are measured on specimens as supplied and also after freezing and crystallization tests. (4) *Moisture expansion.* This is found to have a very low value, averaging about 0.004%. Provided a backing of the material with a similar expansion (cement:sand about 1:8) be used, this small expansion should not have any appreciable effect. (5) *Chemical analysis.* The alkali content appears to have an appreciable effect on the

durability of terra cotta, and analyses are undertaken chiefly to determine the percentage of soda and potash. The results completed up to date show average results of K_2O, 1.5, and Na_2O, 0.6%. (6) *Atmospheric action.* Specimens are exposed to an atmosphere of sulphur dioxide, and the alteration of weight, porosity, etc., determined. The average increase in weight of standard-sized specimens after an exposure of 50 hours is about 0.4%. With a view to obtaining a more rapid laboratory test, solubilities in hydrochloric acid, sulphuric acid, sodium hydroxide, and water are also being measured under various laboratory conditions. The following percentage figures have been obtained to date: hydrochloric acid, 1.23–11.12; sulphuric acid, 0.79–5.92; sodium hydroxide, 3.36–33.82; water solubility, 0.44–3.80. (7) *Sand blast.* This test is made to develop the texture of the ware, and to give a measure of bonding. Results after different methods of artificial disintegration are being compared with the original values. E.J.V.

White Wares

The fused basalt industry. V. NEVEUX. *Genie Civil*, **87**, 57–60 (1925).—Electrical insulators, paving blocks, flag stones, and vessels resistant to chemical action are made from basalt by grinding the rock and fusing in an electric or other furnace at a temperature of approximately 1300°C. The molten mass is poured into sand or other molds, cooled to a glass and reheated in an annealing furnace to produce crystallization. The molded articles are sometimes finished by grinding when exact dimensions are required. The results of tests for dielectric, tensile and compressive strengths, absorption, corrosion, resistance to abrasion, chemical action, and mechanical and thermal shock indicate that the material is in most respects equal to or better than porcelain. H.I.

Ceramics in the industrial exposition at Stuttgart, 1927. HANS VON HEIDER. *Keram. Rund.*, **35**, 808–10 (1927).—Illustrations are given of some of the modern types of pottery exhibited. H.I.

Molded insulating materials. (Standard methods of testing.) ANON. A.S.T.M. Comm. Repts., Part I (Series D48–27), pp. 1099–1100 (1927).—A number of changes have been accepted in the present specifications for testing molded insulating materials. R.A.H.

Fire clay. FRIEDRICH CRAMER, *Sprechsaal*, **60** [50], 940–41 (1927).—Use of fire clay with slips in manufacture of sanitary ware is discussed. R.A.H.

History of porcelain (vitreous whiteware). R. RIEKE. *Sprechsaal*, **60** [52], 992–94 (1927).—A review as to what has been accomplished toward technical control and improvement in the porcelain industry in the past 60 years. R.A.H.

History of whiteware (semivitreous). KARL JACOB. *Sprechsaal*, **60** [52], 996–99 (1927).—The development in this industry during the past 60 years is traced. R.A.H.

White glazed tile and unglazed ceramic mosaic. ANON. U. S. Dept. of Commerce, *Simplified Practice Recommendation*, No. 61. 25 pp. (1927).—The following observations of standards for white glazed tile and unglazed ceramic mosaic are given. (1) The types, shapes, patterns, sizes, dimensions, grade nomenclature, grade marks, grade specifications, and certifications of grades given in the publication are recommended as standards. (2) Catalog illustrations should conform to the recommended standards as nearly as possible and specials should be so designated. (3) Since replacements play a very important part in the use of tile and ceramic mosaic, manufacturers should exercise discretion in the retention or destruction of molds which become obsolete through operation of these recommendations. (4) Various names are now used by architects, manufacturers, and contractors without definition, which tend to encourage misrepresentation and substitution. (5) Plain grade marking which even the layman purchaser can understand. (6) Warpage and manufacturing blemishes on the surface of tile must be considered in grading. (7) The establishment and use of standardized

minimum grade specifications would be greatly facilitated by the adoption of a uniform method for certification of grade. Grade specifications, certification of grades, and explanation of terms used are included. R.A.H.

Talc spark plug porcelain. ANON. *Ceram. Ind.*, **10** [2], 152 (1928).—Analysis of the German Bosch plug gave loss on ignition 0.11, SiO_2 66.43, Fe_2O_3 2.11, Al_2O_3 3.72, CaO trace, MgO 27.78, K_2O 0.02, Na_2O 0.02, TiO_2 trace; 27 bodies were compounded on the basis of this analysis. Test pieces were pressed (semidry), dried, and bisque-fired at 900 to 1000°C. They were coated with a slip prepared from the same bodies to which 1.5% of rutile had been added, and were glost-fired at 1350–1520°C. The glaze, which matured at 1100°C corresponded to the formula:

$$\left.\begin{matrix}0.33\ Na_2O\\0.33\ CaO\\0.33\ PbO\end{matrix}\right\}\ 0.13\ Al_2O_3\ \left\{\begin{matrix}1.73\ SiO_2\\\\0.53\ B_2O_3\end{matrix}\right.$$

Tests for the sudden cooling, sudden heating, electrical resistance at high temperatures, puncture voltage, and microstructure were conducted. The conclusions are (1) that the Bosch ignition plug is probably a talc porcelain; (2) limestone is not a suitable flux for the body; (3) clay acts as a strong flux in magnesia bodies; (4) several bodies better than the Bosch were obtained; (5) bodies made of 80 parts calcined talc and 10–15 parts clay substance are best for talc plugs; (6) kaolin is better than a plastic clay with regard to resistance to sudden changes of temperatures. F.P.H.

Once-fired chinaware. ANON. *Ceram. Ind.*, **10** [2], 162–63 (1928).—The present day manufacturing trend in the ceramic industry is toward straight-line continuous production, and this scheme to no little extent has been accomplished in the glass and enamel fields, while the pottery field has also taken steps in this direction. Practically all dinnerware and hotel china is made today by the twice-fired process. Suggestions are given for a once-fired process of making hotel chinaware. F.P.H.

Once-fired wall tile. ANON. *Ceram. Ind.*, **10** [2], 164 (1928).—Suggestions for a single-unit tile plant are given. A single unit will consist of an automatic tile press, a fettling machine, driers, glaze sprayers, glaze driers, setting conveyer, and tunnel kiln. A method of arranging and operating these units is described. F.P.H.

Boiler efficiency in pottery plant. ANON. *Power*, **31** [14], 764 (1927); *Feuerungstechnik*, **15** [24], 288 (1927).—A pottery plant is described in which 80% boiler efficiency is maintained. F.P.H.

A personality in the pottery industry. ANON. *Pottery Gaz.*, **53** [607], 99 (1928).—A tribute to Edward Probert Evans, who has been associated with the Worcester Royal Porcelain Co., Ltd., in various capacities, since 1866. E.J.V.

A visit to a ballclay mine. ANON. *Pottery Gaz.*, **53** [607], 100–102 (1928).—A description of the Dorset clay works of Pike Bros., at Wareham, near Poole, which has been winning ball clay for pottery and other purposes for more than 150 years and today supplies potters and manufacturers engaged in various other industries throughout the world. The Dorset ball clays are obtained by two principal methods, mining and surface working. These methods are described. Some of the different categories of ball clay supplied by Pike Bros. are discussed. E.J.V.

What is "china"? ANON. *Pottery Gaz.*, **53** [608], 281 (1928).—A discussion of the actual meaning of the term "china." J. W. Mellor says, "Porcelain is a body which in moderately thin layers is translucent." Bernard Moore defines porcelain as a "pottery body which is matured in the firing to such an extent that it becomes translucent." These definitions are, of course, more important when separating pottery into various groups, but, nevertheless, completely rule out the resinous products sold as "unbreakable china." Webster's dictionary states: "China: A species of earthenware originally made in China." "Porcelain: A fine, translucent kind of earthenware." Chambers' Twentieth Century dictionary describes china as "a fine kind of earthenware, originally

made in China." Bourry in his "Treatise on Ceramic Industries" says, "China is translucent, of white body, mat, or with glaze." The indications are fairly plain that the word "china" is applied to the material and not the ware. Historically, "China" was first the designation of certain ware imported from the Far East. Later, when similar ware was made in England, the same name was applied, even though, as in the case of soft porcelain, there was a difference in the ingredients. From this the term came to refer to a particular class of body, irrespective of the use to which it is applied; *cf.*, electrical and laboratory china. E.J.V.

PATENTS

Method of assembling insulators. WALTER T. GODDARD. U. S. 1,657,922, Jan. 31, 1928. The method of connecting the parts of a multipart insulator which consists in applying to the surfaces to be connected a readily expansible noncompressible coating whose expansion coefficient is greater than that of the adjacent parts, interposing between them a cementitious compound, and subsequently subjecting the assembled parts to a relatively high temperature until the cementitious compound has set.

Insulator. ARTHUR O. AUSTIN. U. S. 1,659,183, Feb. 14, 1928. An insulator comprising a dielectric member having a radially extending flange thereon, terminal members connected with the insulator at opposite sides of the flange, and means connected with each of the terminal members for supplying charging current to the flange at points spaced from the terminal members, the means comprising a conductor disk connected with each of the terminal members and extending radially therefrom in spaced relation with the insulator flange, each of the disks being of materially less diameter than the flange and disposed in close proximity thereto adjacent its terminal member but diverging therefrom outwardly.

Pottery and brick-making material. W. GOURDJIAN AND G. L. JONES. Brit. 268,204, July 30, 1926. Gum arabic is incorporated with clay as follows: for tiles, 1½ lb. of gum arabic are mixed with 100 lb. of tile clay and 9 gals. of water, the gum being dissolved prior to mixing in a small quantity of water. For sanitary ware, 1¼ lb. of gum are used to 100 lb. of clay, and for pottery 1¼ lb. gum to 100 lb. of potters' clay. (*T.E.C.S.*)

Shaping pottery. W. J. MILLER. Brit. 280,882, Jan. 18, 1928. Potters' jiggers comprise mold-carrying trays adapted to be moved in a substantially rectilinear plane into operative shaping position, and reciprocating and rotatable chucks arranged to raise intermittently the molds into engagement with the shaping means.

Shaping pottery articles. W. J. MILLER. Brit. 281,323, Jan. 25, 1928. Pottery shaping apparatus comprises means for conveying molds to a position adjacent the shaping mechanism, means for transferring the molds to the shaping mechanism, and means for transferring them, after shaping the material, to further mechanism whereby they are conveyed away, as for example, to a drier.

Pottery molds. S. HANCOCK. Brit. 281,471, Jan. 25, 1928. A locking ring for securing together 2 parts of a horizontally divided plaster mold for use in the jolleying of teapot bodies an other hollow articles is provided with a number of downward extensions having slightly wedge-shaped projections extending circumferentially at their ends for the purpose of engaging under a series of spaced circumferential projections on the top outside edge of the lower portion of the mold. The ring, which may be of aluminium, has an inwardly extending flange to engage a shoulder on the upper portion of the mold, and to facilitate rotation, the ring may have an annular beading.

Equipment and Apparatus

A simplified capillary tube plastometer. J. L. ST. JOHN. *Ind. Eng. Chem.*, **19** [12], 1348–49 (1927).—A description of an apparatus to measure mobility. It is of the capillary tube type and St. J. has applied it to biological materials. R.J.P.

Plaster mold drying temperature. T. N. McVay and J. P. Breen. *Ceram. Ind.*, **10** [2], 196–97 (1928).—The effects of temperature and relative humidity on the strength developed by pottery plaster in setting, and the effect upon its strength by alternate saturation with water or electrolyte are discussed. From the data presented it can be seen that pottery plaster loses strength much more rapidly in the electrolyte solution than in water. This is caused by the fact that the plaster is weakened not only by the effect of solution brought about by the water, but also by the reaction of the electrolyte with the plaster, forming sodium sulphate, thus showing that the minimum amount of electrolytes should be used. This explains why the life of molds used in casting is shorter than that of molds used in pressing. The plaster is practically set at the end of one day, but gains some strength the following day. Although plasters appear thoroughly set at the end of one hour, the hydration process is not complete, and if the piece is placed in the drier at that time the ultimate strength is about 20% less than it would be if left in a saturated atmosphere for 2 days. After 2 days the strength remains constant. To determine the effect of drying temperature on the strength of set plaster, tests were made at temperatures of 45, 60, 65, 70, 85, and 95°C. For each test one set of test pieces was made. The bars were allowed to set for one hour and then placed on the racks in the drier. A constant temperature was maintained in the drier for the respective tests. Each set of test pieces was left in the drier 2 days to allow time not only for drying, but also for partial dehydration. The bars were then removed, allowed to cool, and broken immediately in the cross-breaking machine. According to the results obtained there is no decrease in strength due to drying at temperatures lower than 65°C. Above that point the strength falls off sharply, proving that dehydration of the plaster has taken place appreciably. F.P.H.

The Martienssen methane detector. F. O. Willhofft. *Min. and Met.*, **9** [254], 66–68 (1928).—A portable device for detecting the presence of methane in gassy mines is described. The device is as easily used by a novice as by an expert. F.P.H.

Conveying via the air route. W. B. Spooner. *Chemical Markets*, **22**, 44–46 (1928).—Experiments in pneumatic conveying were made for handling grain in England in 1865, and in the U. S. by A. K. Williams for handling loose cotton in 1867, but it was not until 1892 that F. E. Duckham initiated modern pneumatic conveying. There are 2 general types, the vacuum and the pressure types. Each type is suitable for its own problems. The advantages of pneumatic conveying are: labor-saving, dustless operation, lower upkeep, ease of installation, wide range of application. H.H.S.

Drying plant memoranda. C. H. Butcher. *Ind. Chemist*, **3**, 554–56 (1927).—Deals with designs of plant, selection of temperature conditions, calculation of air requirements for a tunnel drier (covering air required to evaporate moisture, to heat the material, to heat trucks and trays, to cover radiation and leakage), humidity of air leaving drier, and notes on the construction of tunnel driers, air velocity, direction of flow, and time required for drying. H.H.S.

Importance of grading in industry. C. Cluett. *Ind. Chemist*, **3**, 568–72 (1927).—The most efficient screening plant is that in which the screening surface is made to move or vibrate. The failure of the stationary screen is due to the "arching" of the material, which is overcome by vibration. Revolving screens are, however, fundamentally wrong; when the screen rotates, the coarse material rolls ahead of the fine and fills the screen openings. The vibrating screen is much more efficient; the coarse particles are forced up and away from the screen, while the fines hug the screen, and even when damp, the effect of the impact is to keep the mass broken and the meshes open. The vibration should be adjustable, as in the Hummer electric screen. H.H.S.

The dust problem. G. C. Polk. *Power Age*, [11], 29–31 (1927).—Dust has been defined as "matter in the wrong place." The yearly precipitation of soot per square

mile is nearly 2000 T. in Pittsburgh, 1530 T. in Baltimore, and almost as bad in some other cities. Other dusts, especially fine dusts, present difficult problems. The Cottrell electrical system is said to be practical only where the reclaimed dust has great value. The Sirocco collector, here advocated, a centrifugal separator, was invented by the Davidson Co. of Belfast and has been taken up by the American Blower Co. It was found that the cylindrical chamber and tapering cone connection result in interior turbulence. A volute or scroll-shaped chamber was therefore adopted, terminating at its smallest radius with the larger diameter of the conical casing below. H.H.S.

Fans increase kiln capacity. ANON. *Brick Clay Rec.*, **72** [3], 199–201 (1928).—A description of the Danville Brick Co., of Danville, Ill., where, by installation of a fan system, an increase of about 20,000 brick per day was effected without any increase in actual kiln capacity. Besides the conventional red shades, deep greens, browns, and many other shades are produced, but the finest achievement is a deep purple blended in what is called "heather mix." A green brick of a hue seldom seen in a face brick plant is also produced. A detailed description of the plant equipment is given. E.J.V.

Car dumper installation of unique design. ANON. *Eng. News-Rec.*, **99** [15], 602 (1927).—Two illustrations of this unique dumper are shown with the cradle of the dumper rolled up an incline instead of being revolved upon equalizing rollers. This installation is at the plant of the Florida Portland Cement Co., Tampa, Fla. Steel girder runways are inclined at about 35° and the machinery for rolling the cradle up the incline is mounted on a foundation at the ground level under the crusher tower. A 115 H.P. motor fitted with a geared limit switch is used to slow down and stop the rolling of the dumper in either direction. This dumper will handle open top cars from 7–12½ ft. high, 9–10½ ft. wide, and 50 ft. long, with a total loaded weight of 220,000 lbs. It is stated that 20 cars per hour can be dumped. The dumper was designed and constructed by the Wellman-Seaver-Morgan Co., Cleveland, Ohio. G.W.W.

Earth moving mechanized. CHAS. H. PAUL. *Eng. News-Rec.*, **100** [1], 67–69 (1927).—The development of excavating machinery since the invention of the power shovel has produced equipment suited to widely varied conditions. The distinctive types and their fields of application are here outlined. G.W.W.

A self-registering sedimentation scale that indicates the sedimentation curve directly. A. H. M. ANDREASEN. *Sprechsaal*, **60** [47], 869–71 (1927).—An apparatus for fractionating slips and making fineness determinations by sedimentation is described. R.A.H.

PATENTS

Apparatus for separating matter of different specific gravities. HUGO VELTEN. U. S. 1,646,506, Oct. 24, 1927. A method of separating granular materials by an air current comprising providing a fluid current of constant velocity in a passage, moving the walls of the passage in the same direction as the fluid current and approximately at the same speed, scattering the granular material in the current and separately discharging the particles suspended in the current and those which sink therein.

Transfer car. ALBERT E. EVANS. U. S. 1,657,206, Jan. 24, 1928. In a transfer car having a car receiving track thereon, supporting wheels at the sides of the car, independent shafts for the wheels on one side of the car, each of which has its ends eccentric with respect to the portion of the shaft therebetween on which the wheel is journaled, a pair of bearings for each shaft in which the shaft is adjustably held against rotation, the bearings being mounted on the car for horizontal adjustment, means for clamping the bearings in adjusted position, a driven shaft extending longitudinally on the side of the car, a gear carried by each of the shafts for the wheels, and gears on the driven shaft for driving the gears on the wheel shafts.

Drying bricks. M. M. MINTER. Brit. 265,449, June 18, 1926. The bricks are supported on trucks which move step by step through adjacent tunnels in a countercurrent of hot air. Baffles are arranged in the tunnels to give the air a spiral motion. The arrangement of ducts, etc., is described. (*T.E.C.S.*)

Filter press. A. M. CAPRA. Brit. 278,940, Feb. 14, 1927. A filter of the plate-and-frame type, but with vertical axis, is arranged so that the frames are attached to a fixed vertical board or post, and the plates are attached to a board or post that slides horizontally. The upper faces alone of the filter plates are pervious, the bottoms being unperforated and forming trays which collect the filtrate and conduct it to the outlet. When the press is full the clamping pressure is released and the plates are withdrawn, thus permitting the cakes to drop through the frames to a vessel below. The operation of withdrawing the plates also scrapes the filter surfaces ready for re-use. (*B.C.A.*)

Spraying enamel and glaze. A. PAHL. Brit. 281,885, Feb. 1, 1928. Spraying apparatus for coating metal, stone, or other surfaces with glass, enamel, or like substances is characterized by the powdered coating material being blown on to the surface to be treated in an unmelted nonplastic condition where it is fused by the heat of the surface.

Kilns, Furnaces, Fuels, and Combustion

Round kilns or muffle kilns for the firing of under-glaze decorations? OTTO TIPPMANN. *Keram. Rund.*, **35**, 821–23 (1927).—Although muffle kilns as usually fired use much more coal than do round kilns, changes in construction and in manner of firing can make muffle kilns the equal of round kilns in fuel economy. Examples showing the usefulness of flue-gas analyses in correcting firing procedure are given. H.I.

Progress in fuel utilization in 1927. JOHN VAN BRUNT. *Mech. Eng.*, **50** [1], 22–28 (1928).—Rapid and well-balanced development of equipment and methods previously introduced noted rather than new innovations in fuel utilization. The bituminous coal situation is discussed with tables showing increased production and increased electrical output per ton of coal used as compared to the previous year. There has been rapid growth in machine cutting and machine loading at the working face, showing increased output per man. Improved methods of washing and sizing coal and the use of larger mine cars are noted. The use of coal preparation methods continues to increase. There is a trend toward the use of some form of water-cooled walls to increase the capacity, efficiency, combustion conditions, and to reduce furnace maintenance costs. The use of Carborundum refractories for the clinker zones of front, side, and bridge walls and the clinker pits of stoker-fired furnaces burning bituminous coal has proved to be excellent practice. The solid brick appear to be much longer lived than the perforated blocks. There have been 3 major changes in stoker construction: (1) increased length, (2) improved air distribution methods, and (3) structural changes to use more highly preheated air. The developments taking place with chain grates are quite analogous to those made on stokers. A remarkable increase in the use of pulverized fuel, and increasing attention has been paid to the extension of the turbulence principle in pulverized-coal burner design. Future development must be with mills for pulverizing coal to smaller size particles. Low-temperature carbonization of coal has been put on a commercial basis in this country. There has been a rapid extension of domestic oil-burning equipment. The use of manufactured gas is undergoing steady growth. Briquetted domestic fuel from Rhode Island anthracite by the use of the Trent process is an accomplished fact on a small scale. The maximum daily production of petroleum was attained in this country in 1927 when the highest daily output was 2,500,000 bbls. In Germany the Bergius process for the liquefaction of coal has been placed on a commercial scale. The coke dry-quenching process installed at Rochester has created much

interest. The foreign developments are outlined. The field of fuel research, at present, is almost untouched. Some problems for research are suggested. G.W.W.

Measuring kiln draft. ANON. *Brit. Clayworker*, **36** [429], 302 (1928).—The ordinary draft gage measures only the static draft; *i.e.*, the pressure of the air or gases in the kiln or flue. It does not show the movement of the air or gas or how much of it is passing through at any given time. Yet it is the latter, the dynamic draft, which is of chief importance in controlling a kiln. The dynamic draft is proportional to the speed at which the gases travel, and corresponds to the equation: $p_d = v^2 s/2g$, where v is the velocity of the air or gases, s the density multiplied by 1000, and g the gravity coefficient. The total draft is the sum of the static and dynamic drafts, *i.e.*, $P_t = p_s + p_d$. The dynamic draft is measured by means of a Pitot tube which is described. R.A.H.

History of ceramic kiln building. JULIUS LAMORT. *Sprechsaal*, **60** [52], 1010–13 (1927).—A brief review and discussion of development of the kiln. Periodic kiln, ring furnaces, joined kilns, tunnel and muffle kilns of the past 60 years are reviewed. R.A.H.

History of combustion (firing) technology. HUGO HERMAN. *Sprechsaal*, **60** [52], 1050–53 (1927).—A review of 60 years development of technical control of firing and burning. R.A.H.

Tar as fuel for furnaces. W. A. FORBES. *Amer. Iron Steel Inst.* (Advance Paper, N. Y. Meeting), pp. 39–42 (1927).—One of the more important changes since 1920 has been the general increase in use of tar and coke-oven gas, replacing producer gas and natural gas. There has been a drop of approximately 10% in the use of producer gas and a like increase in the use of tar alone. The figures for 1926 and 1920 (1920 in parentheses) showing percentage of total tonnage of steel made according to the type of melting fuel used are: producer gas 40.6% (50.1), tar alone 10.6 (0.0), coke-oven gas alone 3.8 (0.0), fuel oil alone 2.7 (5.5), natural gas alone 2.7 (5.3), powdered coal alone 0.0 (0.5), coke-oven gas and natural gas 13.1 (11.8), coke-oven gas, tar, and fuel oil 3.9 (0.0), coke-oven gas and tar 16.2 (23.5), coke-oven gas, natural gas, tar, and fuel oil 6.2 (0.0), tar and fuel oil 0.2 (3.3). H.H.S.

The use of briquet fuel in the ceramic industry. J. DORFNER. *Ber. deut. keram. Ges.*, **8** [5], 249–58 (1927).—A discussion is given of the application of briquet fuel to various kilns and furnaces in the ceramic industries of Europe. F.P.H.

Calculating heat value of fuels from their chemical composition. R. VONDRACEK. *Brennstoffchemie*, **8**, 22–23 (1927); *Ber. deut. keram. Ges.*, **8** [5], lxxiii (1927). F.P.H.

Control of soot in gas-producer practice. ROYDEN A. BLUNT. *Ceram. Ind.*, **10** [2], 153–55 (1928).—A report of an investigation at the Corning Glass Works for the purpose of controlling the amount of soot produced by gas producers. This investigation included all the briquetting schemes and water systems. The former were discarded after preliminary experiment because they were too expensive and the nature of the soot made them of doubtful commercial value. Water systems were investigated and employed to the point where it was found that water could be depended upon as a conveyer only Approximately 100% of the soot formed will float and tests showed that it could be submerged for months and upon being released would rise to the top of the water with the buoyancy of cork. Where water systems were employed the soot could be collected, but each passing gust of wind distributed it around the surrounding territory. The final problem of disposal was always present. Soot legs and traps in the gas system were also discarded for the reason that, while they collect, they also leave the problem of ultimate disposal unsolved. The system and method of operating the soot disposal plant are described in full. F.P.H.

Tunnel kiln that runs itself. ANON. *Ceram. Ind.*, **10** [2], 194–95 (1928).—A description of a tunnel kiln and to operation at the Fraunfelter China Co. F.P.H.

The American mechanical gas producer. WILHELM G. DIENES. *Feuerungstechnik*, **15** [25], 292–94 (1927).—The Hughes generator is described. Data are given on the cost of operation of this producer using several grades of coal. The analysis of the coals and gas are given. F.P.H.

Reactivity and the quality of coke. G. AGDE. *Feuerungstechnik*, **15** [26], 301–304 (1927).—A discussion is given of the requirements in regard to quality of important types of coke on the basis of the theory of the reactivity of anthracite coke. F.P.H.

High gas pressure for gasification in the gas producer. J. GWOSDZ. *Feuerungstechnik*, **15** [26], 304–306 (1927).—The effect of pressure and combustion surface on the reaction velocity is considered. F.P.H.

Vaporization of heavy oil and its recent solution. JOSEF SIMON. *Feurungstechnik*, **15** [27], 313–15 (1927).—The following subjects are discussed: (1) Schematic molecular structure combustibles, (2) the vaporization problem and the maximum transformation velocity of the combustibles to water gas, (3) thermal decomposition and vaporization of heavy hydrocarbons, (4) the constructive principles of a new method, (5) the action of superheated steam on heavy hydrocarbons, (6) the mechanical loosening of the molecular bonds, (7) firing with heavy oil with blue, faintly luminous, not smoky and not sooty water-gas flame. F.P.H.

High quality generator gas from low quality fuel. RUDOLF CZERNY. *Feuerungstechnik*, **15** [29], 377–42 (1927).—The subjects considered are (1) normal gasification (2) gasification with the addition of hot generator gas below the vaporization zone, (3) gasification in the upper vaporization bed with the addition of hot generator gas below the vaporization zone, (4) comparison of these three types of gas by determining the combustion temperature, (5) economy of the gasification methods, (6) calculation of the gas composition and the heating value of a normal producer, (7) calculation of the combustion temperature. F.P.H.

The cleaning of coal. XVII. CHAPMAN AND MOTT. *Fuel*, **6** [8], 340 (1927); *Feuerungstechnik*, **15** [25], 299 (1927). F.P.H.

Less use of dampers gives better products. OTTO POMMER. *Brick Clay Rec.*, **72** [2], 107–10 (1928).—The use and misuse of the dampers on kilns are discussed. Theories regarding firing with excess air and draft, or with the dampers closed or open are discussed. The question of economically firing a kiln is taken up, showing the effects of short fast firings and slow moderate firings on both the ware and the kiln proper. The different firing time for different clays must also be considered. P. believes that less use of dampers in the kilns gives better speed in the firing and better quality in the ware. E.J.V.

Development of the tunnel kiln. R. SYLVANY. *Pottery Gaz.*, **53** [607], 116–21 (1928).—Practical and accessory difficulties encountered in the first tunnel kiln plant built in France, between 1751 and 1765, at Vincennes, were responsible for the fact that no other plants were built until 1840 when a tunnel kiln was constructed in Denmark. Other developments in different countries are touched upon. The advantages of continuous tunnel kilns are discussed. In France the tunnel kiln is making headway; it has there been found to be the solution for maintaining profits under the stress of competition. Data on several different tunnel kilns in use in different kinds of ceramic plants are given. A discussion of the article follows. E.J.V.

Bisque firing by tunnel oven. JOSEPH BURTON. *Pottery Gaz.*, **53** [607], 121–22 (1928).—Tunnel ovens of the muffle type have been very successfully used during the last dozen years in the tile industry of Great Britain for glazing purposes, and some years ago the late Mr. Marlow, of the firm of Minton, Hollins & Co., Stoke-on-Trent, erected an open-fired tunnel oven for the firing of bisque ware. These open-fired tunnel ovens had, however, been in use on the Continent for many years; they were

brought into modern practical applications by M. Faugeron, who built many such ovens in various places. In the Faugeron oven the products of combustion were taken directly into the tunnel and played directly around the saggers containing the ware. The oven designed by Sylvany was also one of the open-fired type, and, after having had experience of the working of this particular oven for nearly two years, one could say that, at all events as far as tile is concerned, it operates more or less successfully. The goods were fired to about 1140°C, sixty hours being taken to attain this maximum temperature. Trucks passed through the 304 ft. tunnel in 100 hours. A further detailed description of the Sylvany oven is given. The firing of bisque pottery is a much more scientific matter than lime burning, cement burning, or the calcination of magnesite, where it is merely a question of the realization of a certain temperature. In dealing with clay goods care must be taken between 500 and 650°C, when the water of combination is being driven off. The "soaking" period is another important phase in firing clay goods. It was found to be true that of two tile fired for different lengths of time but glazed and fired again in similar circumstances, the one which was fired more quickly in the bisque firing would craze while the other would not. This seemed to prove that a "soaking" was necessary, and the Sylvany oven was designed to permit a period of eight hours for "soaking." The advantages of a tunnel oven for firing bisque ware are summarized.

E.J.V.

Determination of the total amount of water injected into a producer. R. MARTIN. *Chal. et Ind.*, **8**, 182 (1927).—The weight of water to saturate 1 cm. of dry air (0 and 760 mm.) at temperatures up to 100° is calculated and the heat contained at each temperature found. The heat content of the air, Q, when containing P g. of water at $t°$ is: $Q=(0.00053t+0.617)P+310t$. If into this air superheated steam containing x cal. per g. is injected, the heat content q_m and watervapor content P_m of the mixture are given by $\frac{Q_m-Q}{P_m-P}=x$. With an effective temperature of the mixture of $t_m°$, P_m can be calculated from: $\phi_m=(0.00053t_m+0.617)P_m+0.310t_m$. This equation serves also to calculate the amount of water P_m condensed in raising the air from $t°$ to $t_m°$. Finally, a knowledge of the relationship between the composition of the coal and of the gas produced allows of the computation of the volume of air required per kg. of coal, from which the steam to coal ratio is determined. The method indicates that 628.4 g. of steam are taken up per kg. of coal in a particular producer, and actual measurement gives a value of 635 g. per kg. (*J.S.G.T.*)

Extraction of sulphur dioxide from flame gases by glasses and glazes. A. FABER. *Gas. und Wasserfach*, **70**, 419 (1927).—Berdel concludes that the varying effects in the firing of porcelain and stoneware in simple and in tunnel ovens depends on the state of oxidation of the sulphur in the gases. Even chemically resistant glazes with high silica and alumina content do not escape action of the sulphur in strongly oxidizing atmospheres. Bole and Jackson state that the compounds formed by the SO_2 and SO_3 are decomposed above 800° into the oxides. Clay does not absorb the sulphur compounds to a degree proportional to the content of these in the gas, and the increase of gas velocity in the range 400–765° is more effective in removing the compounds than rapid increase of temperature. Eitel found that the higher the temperature the more suitable the conditions for the further escape of the absorbed SO_2. He also agrees with Berdel that the type of gas absorbed depends on the chemical composition of the glass. Ortmann found rapid SO_2 absorption by enamel glazes at 700–875°, and recommends as its prevention good furnace draft with restrained oxidizing firing conditions. Schoblick considers alternate reducing and oxidizing conditions to be necessary. The work of Travers on the absorption of sulphur gases is confirmed by the work of Berdel, Ortmann, Zschimmer, and others. The effect of the sulphur compounds in the gas thus

depends on the concentration and state of oxidation of these under fixed conditions of firing. Technically, the fault can be avoided by suitable firing, *i.e.*, by a reducing atmosphere followed by oxidizing conditions. (*J.S.G.T.*)

A new definition of the quality of gas. GOFFREDO WOBBE. *Ind. Gas acquedotti* (Rome), Nov. 30, 1926; *Monats-Bull. schweiz Ver. Gas- u. Wasserfach*, 7, 277–78 (1927).—The value of the ratio $p\sqrt{S}$ (p is the calorific value of the gas and S is the specific gravity determines how much heat will be secured from a given burner in a given time. Methods of determining the value of the ratio are given. (*C.A.*)

Combustion of complex gaseous mixtures. III. G. B. MAXWELL, W. PAYMAN, AND R. V. WHEELER. *Jour. Chem. Soc.*, p. 297 (1927).—A study of the inflammation of mixtures of carbon monoxide and hydrogen with air in a closed vessel is reported. (*T.E.C.S.*)

The ignition of gases. VI. Ignition by flames. Mixtures of the paraffins with air. N. S. WALLS AND R. V. WHEELER. *Jour. Chem. Soc.*, p. 291, (1927). (*T.E.C.S.*)

Producers for the gasification of high and low quality fuels and of waste products. H. BARTH. *Keram. Rund.*, **34,** 494 (1926).—After a discussion on the economic factors relative to the use of coal, slack, lignite briquets, and peat as fuel for industrial purposes, B. describes a patented producer that could be adapted with slight alterations for the gasification of all grades of fuel from rough coal to waste sludge. The grate (the most important part of the producer, according to B.) can be arranged without rebuilding, either as a step grate, flat grate, or combination of the two. A special feeding device permits the producer being used for the gasifying of fine coal or sludge, these being fed into sloping shafts at the sides of the producer. A central feeding hopper permits the simultaneous feeding in of other fuel, peat, briquets, or coal. It is possible with such a generator to produce gaseous fuel adequate to the heat requirements of a furnace at a much less cost than when fuel of good quality is used, since the fine coal and washer sludge is in the nature of a waste product at the pit head and is obtainable at a very cheap rate. Diagrams are given. (*J.S.G.T.*)

Industrial oil firing. ANON. *Manchester Guardian Commercial*, Jan. 20, 1927.—Oil-burning installations have been adopted for firing furnaces or ovens in one instance in the potteries with considerable success. Fuel oil, atomized by steam, is burned from a simple burner with adjustable nose-cap. The steam is at 40 lb. pressure and the jet aperture $^{7}/_{64}$ in. The following relative figures for coal and oil firing are obtained for a biscuit oven: (*J.S.G.T*)

	Coal	Oil
Fuel burnt	$14^{3}/_{4}$ tons	$6^{1}/_{4}$ tons
Price per ton	32*s.* (pre-strike)	92*s.* 6*d.*
Time of firing	54	33
Loss per oven	4.26%	2.47%

	Coal Firing						Oil firing		
	Pre-strike			Jan. 1927					
	£	*s*	*d*	£	*s*	*d*	£	*s*	*d*
Fuel cost	24	0	0	41	0	0	28	10	0
Loss	27	0	0	27	0	0	13	5	0
Total	51	0	0	68	0	0	41	15	0*

* Not including expense of steam which cost about 9*d.* per hour. (*J.S.G.T.*)

BOOK

Manual of the Technology of Fuels. H. STRACHE AND H. ULMANN. 471 pp. with 81 illustrations in text. Franz Deuticke, Leipzig und Wien, 1927. *Feuerungstechnik*, 15 [25], 299 (1927). F.P.H.

PATENTS

Tunnel kiln. WILLIAM LEE HANLEY, JR. U. S. 1,658,331, Feb. 7, 1928. In a tunnel kiln, the combination of a duplex firing chamber having 2 separate firing zones provided with heating means located on opposite sides of the duplex firing chamber, and a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, provided with parallel goods conveying means movable in opposite directions each of which passes through one of the firing zones, each of the end sections forming a combined cooling and preheating zone, means for introducing a gaseous heat modifying fluid into each of the end sections, at different points longitudinally thereof, independently operable means for controlling the introduction of the heating fluid at such points, and means for withdrawing the moist air vapor gases from the end sections of the kiln.

Twin-tunnel kiln. WILLIAM LEE HANLEY, JR. U. S. 1, 658,332, Feb. 7, 1928. In a twin-tunnel kiln, the combination of a duplex firing chamber, having 2 firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, means for withdrawing the products of combustion from each firing zone, a duplex-tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a preheating chamber communicating with the inlet end of one firing zone and a cooling chamber communicating with the discharge end of the other firing zone, the preheating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones and the preheating and cooling chambers at the opposite ends thereof.

Tunnel kiln. WILLIAM LEE HANLEY, JR. U. S. 1,658,333, Feb. 7, 1928. A single, tunnel kiln comprising among its members, a centrally located firing chamber provided with a series of furnaces at different points longitudinally thereof discharging their products of combustion into a firing zone within the firing chamber, independent means for controlling the furnaces for maintaining a gradually increasing temperature from one end of the firing zone to the other, means for withdrawing the products of combustion from the firing zone, a preheating chamber located at one end of the firing chamber, means for utilizing the products of combustion withdrawn from the firing zone for heating air and discharging it into the preheating chamber to effect the preheating, watersmoking, and oxidation of the products, a cooling chamber connected with and extending from the opposite end of the firing chamber, and a single line of goods conveying means extending through the preheating chamber, firing chamber, and cooling chamber.

Continuous kilns. H. WEBSTER. Brit. 269,344, Oct. 17, 1925. Separate kilns are connected in series by diametral flues beneath the floors, an external longitudinal flue for each line of kilns, and a pair of transverse flues between adjacent kilns. Each chamber has peripheral fire boxes, a bag wall, a perforated floor, and an annular flue, which communicates with the diametral flue of the next chamber. (*T.E.C.S.*)

Geology

Notes on the triclinic pyroxenes. A. N. WINCHELL. *Amer. Mineral.*, **12** [1], 10–14 (1927).—In summary, there is a group of triclinic minerals usually (but incorrectly?) referred to the pyroxene group whose formulas and mutual relationships are still uncertain. This group consists of metasilicates of manganese and calcium in which the ratio between manganese and calcium seems to vary from 1:0 to 1:1. These minerals differ too much optically and crystallographically to belong to an isomorphous series in the narrow sense of that term. The chief types thus far known are:

Mineral	Formula	Ratio of Ca to Mn(+Fe+Mg)
Pyroxmangite	$(Fe, Mn)SiO_3$	1–1 or 0–1
Sobralite	$CaMgFe_2Mn_4(SiO_3)_8$	1–7
Rhodonite	$CaMn_3(SiO_3)_5$	1–5
Fowlerite	$Ca(Mn, Fe, Zn)_3(SiO_3)_5$	1–5
Vogtite	$Ca(Mn, Fe, Mg)_2(SiO_3)_3$	1–2
Bustamite	$CaMn(SiO_3)_2$	1–1

Babingtonite probably belongs to this group, but its formula is still under discussion. F.P.H.

Kernite, a new sodium borate. WALDEMAR T. SCHALLER. *Amer. Mineral.*, **12** [1], 24–25 (1927).—The new mineral kernite, $Na_2B_4O_7 \cdot 4H_2O$, is reported to occur in quantity in the southeast corner of Kern County, Calif., in the Kramer boron district. The mineral was discovered in exploratory borings at a depth of several hundred feet. Ulexite and possibly colemanite are associated minerals. The mineral is colorless to white, transparent, vitreous to pearly in luster, and greatly resembles some specimens of massive cleavable selenite. It is orthorhombic; has perfect prismatic cleavage; $m \wedge m = 71°08'$; readily breaks into long thin fibers and laths; hardness about 3; specific gravity 1.953; optically probably negative, although 2V is nearly 90 and sign uncertain; elongation (c axis) positive; axial plane is parallel to elongation; $\alpha = 1.454$, $\beta = 1.472$, $\gamma = 1.488$. Before the blowpipe it swells considerably and finally fuses to a clear glass. It dissolves very slowly in cold water, the clear cleavage pieces first becoming opaque white due to abundant etch figures. The ratio of the analysis of kernite are: Na_2O: B_2O_3: $H_2O = 365:727:1472$ or 1.00:1.99:4.02, the formula for kernite being $Na_2O \cdot 2B_2O_3 \cdot 3H_2O$. Not quite $^1/_2$ the water is readily given off at 110 and only $^3/_4$ of the total water is lost up to 200°C, there being no swelling of the mineral at this temperature. The relationships of the water content and physical and optical properties of kernite and the other hydrates of $Na_2O \cdot 2B_2O_3$ (borax and "octahedral" borax, the 5-hydrate) are being studied. Crystallization of a water solution of kernite yields 1.39 times as much borax. F.P.H.

Boehmite, the hydrated alumina of bauxite. JACQUES DE LAPPARENT. *Compt. Rend.*, **184,** 1661–62 (1927); *Amer. Mineral.*, **13** [2], 72 (1928).—A list is given of the crystallographic, chemical, physical, and optical properties of Boehmite. F.P.H.

Minerals in Dutch Guiana. E. A. KLINSKI. *Min. and Met.*, **9** [254], 59–61 (1928).—Notes on a colony, that has been of little importance from a mineral standpoint but promises to become an important producer of bauxite, are given. F.P.H.

Platinum metals and their alloys. FREDERIC E. CARTER. *Min. and Met.*, **9** [254], 78 (1928).—Sources of platinum and its metallurgy are discussed. F.P.H.

Working methods of practical geophysics. HANS HAALCK. *Min. and Met.*, **9** [254], 78 (1928).—This is taken from a book "Die Magnetische Verfahren die angewandte Geophysik" by H. who is head of the exploration department of the North American Exploration Co. F.P.H.

The Eötvos torsion balance method of mapping geologic structure. DONALD C. BARTON. *Min. and Met.*, **9** [254], 83 (1928).—B. discusses the theory of the Eötvos torsion balance, the factors determined by it, the interpretation of these results and the limitations of the instrument in determining geologic structure. A short but most excellent bibliography concludes the paper. The last part of the paper deals largely with the future of the torsion balance. The need for study and the training of man in the mathematics of interpretation is emphasized. F.P.H.

Feldspar and mica in 1927. ANON. *Rock Prod.*, **39** [26], 155–56 (1927).—For many years the feldspar industry drifted without systematic method of grinding for ceramic uses. Grinding mills now blend to suit the requirements of different manufacturers

and deposits are analyzed and careful record made of their analyses. Producers recognize the importance of a standard grading, yet are loath to make it an accomplished fact. Steps have been taken by several large producers along this line and more are expected to follow. Another problem awaiting solution is the economic disposal of the large amounts of second-grade feldspar (containing mica and quartz) produced at all reliable mining operations. The Bureau of Standards has been asked to make a scientific investigation to determine new uses for the material, which at the present time is an absolute loss. The feldspar industry is so allied with the ceramic industries that its future seems to rest entirely with the development of ceramics. New fields are constantly being opened in ceramics, thus widening the feldspar market. The producer should help the cause along by seeking out the qualities in feldspar and presenting them to its users; in this way many improper results credited to poor feldspar can be corrected, especially as it often happens that the feldspar is of good quality but of the wrong chemical constitution for the particular product. F.P.H.

Technology and uses of silica and sand. W. M. WEIGEL. Bur. Mines, *Bull.*, 266, 204 pp. (1927).—The work includes a description of the forms of silica which are divided into mineralogical and commercial forms. Under mineralogical forms are described the crystalline silica which covers quartz, tridymite, cristobalite, the inversion of certain forms of silica, and amorphous silica. Under commercial forms are described, quartz, quartzite, sandstone, sand, gravel, tripoli, diatomaceous earth, flint, silex, pulverized silica. Each of the commercial forms are taken up and discussed as to occurrence, prospecting and examination, mining methods, preparation for the market and uses. A bibliography and 50 illustrations are included. R.A.H.

Chromite in 1926. J. W. FURNESS. Bur. Mines, *Mineral Resources of the U. S.*, Part I, pp. 1–8 (1927). R.A.H.

Graphite in 1926. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 91–97 (1927). R.A.H.

Feldspar in 1926. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 109–19 (1927). R.A.H.

Potash in 1926. A. T. COONS. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 119–25, Oct. 1927. R.A.H.

Magnesium and its compounds. J. M. HILL. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 127–40, Oct. 1927. R.A.H.

Gypsum in 1926. R. M. SANTMYERS AND JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 141–50 (1927). R.A.H.

Silica in 1926. ANON. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 169–173.—Production and value of quartz and ground sand and sandstone is discussed. A paragraph on imports is included. R.A.H.

Lime in 1926. A. T. COONS. Bur. Mines, *Mineral Resources of the U. S.*, Part II pp. 183–93 (1927). R.A.H.

Talc and soapstone in 1926. B. H. STODDARD. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 203–209.—A discussion of talc is given which is followed by production, list of producers, review by states, uses, imports and exports, and world production. R.A.H.

Potarite, a new mineral. L. J. SPENCER. (Meeting Mineralog. Soc., Jan. 10.) *Chem. and Ind.*, **47**, 102 (1928).—A brittle white metallic-looking mineral found on the Potaro River, British Guiana, proves to be PdHg, with a density (15.0–16.1) considerably higher than that of either of the component metals. H.H.S.

Inversion of calcium silicate. C. E. TILLEY. (Meeting Mineralog. Soc., Jan. 10.) *Chem. and Ind.*, **47**, 102 (1928).—The inversion of Ca_2SiO_4 in a metamorphic limestone from Larne, County Antrim, Ireland, was demonstrated. H.H.S.

Uranium and other radioactive minerals in S. Africa. ANON. *Chem. and Ind.*, **47**, 104 (1928).—Important deposits of U and other ores, believed to cover a large area, have been discovered on Crown land in Gordonia, Cape Province. Official analyses indicate that the content of U and Th is very high, and considerable importance is attached to the economic value of the discovery. H.H.S.

The origin and occurrence in Rockbridge, Co., Virginia, of so-called "bentonite." A. W. GILES. *Jour. Geology*, **35**, 527–41 (1927).—Material from this region previously described as bentonite does not possess the physical properties of bentonite. It has a schistose structure and appears to be a high alumina shale. Moreover the parent rocks are plutonic and not volcanic. (*C. A.*)

The geology, petrography and mineralogy of the vicinity of Italian Mountain, Gunnison County, Colorado. WHITMAN CROSS AND E. V. SHANNON. *Proc. U. S. Nat. Museum*, **71**, 1–42 (1927).—The minerals are mainly silicates such as are commonly produced in contact zones where a sedimentary section of various rocks, largely carbonates, is penetrated by extensive igneous bodies. The reactions resulting in the new compounds arise from the permeation of the sediments under a condition of high heat, long sustained, by hot aqueous solutions carrying absorbed gases and other mineralizing agents. The particular interest of this occurrence lies partly in the unusual perfection of development of some species, 28 of which are described crystallographically. Of these garnet, diopside, sahlite, vesuvianite, epidote, feldspars, titanite, and scolecite are the more thoroughly studied. (*C. A.*)

BOOKS

Geology and Natural Resources of Colorado. RUSSELL D. GEORGE. xv+228 pp. **Colorado: Its Past and Present.** G. NORLIN and seven others. x+202 pp. Boulder, Colo.: Univ. of Colorado, 1927. Price $2.00 each. Volumes issued by the Univ. of Colorado to celebrate the first half-century of its existence. Reviewed in *Times Lit. Suppl.*, Jan. 19, 1928. H.H.S.

Chemistry and Physics

Isomorphous relations of $MgSiO_3$ and Al_2O_3 in silicates. A. N. WINCHELL. *Amer. Mineral.*, **13** [2], 52–56 (1928).—There seems to be numerous examples of a simple isomorphous relationship between $MgSiO_3$ and Al_2O_3 in silicates. Even in the simple molecule, $MgSiO_3$, the molecule Al_2O_3 may apparently enter isomorphously to a limited extent, such as about 5% in enstatite and 10% or more in anthophyllite. In certain larger molecules, such as diopside, $CaMgSi_2O_6$, and the equivalent amphibole molecule, Al_2O_3 seems to be miscible to about the same extent. F.P.H.

Determination of iron and lime in potter's clay. ANON. *Keramos*, **6** [9], 342 (1927). F.P.H.

Reduction of roasted cassiterite concentrates. W. W. LOO AND E. F. KERN. *Min. and Met.*, **9** [254], 83 (1928).—Conditions and ore composition influence the degree and manner of separating out tin by roasting. A thorough discussion of this subject is given. F.P.H.

The laws of chemical crystallography. V. M. GOLDSCHMIDT. *Naturwissenschaften*, **21**, 477–85 (1926); *Amer. Mineral.*, **12** [1], 28–31 (1927).—A review of the important points brought out in this article is given by E. T. Wherry. The 13 principal theorems are translated in full. The subjects considered are (1) laws concerning size of crystal components, (2) laws concerning deformability of crystal components, (3) laws concerning isomorphism, (4) laws concerning polymorphism and morphotropism. F.P.H.

Manganese and steel in pig iron; volumetric determination by the vanadate method. L. E. STOUT AND G. C. WHITAKER. *Ind. Eng. Chem.*, **22** [2], 210–12 (1928).—A method

is described for the determination of manganese by the vanadate method. The preparation of the standard vanadyl sulphate solution from ammonium metavanadate and the effect of silver sulphate concentration on the rate of oxidation of manganese from manganous nitrate to permanganic acid are discussed. R.J.P.

Studies of the system calcium oxide-alumina-ferric oxide. W. C. HANSEN, L. T. BROWNMILLER, AND R. H. BOGUE. *Jour. Amer. Chem. Soc.*, **52** [2], 396–406 (1928).—The investigation of the system calcium oxide-alumina-ferric oxide has been undertaken in order to aid in the determination of the composition of Portland cement and the rôle played by each component in the manufacture and utilization of cement. Only that part of the system which is related to Portland cement has been studied. One ternary compound has been found in the system having the formula $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ and melting congruently at $1415 \pm 5°C$. Its refractive indices are $\alpha_{Li} = 1.96 + .01$, $\beta_{Li} = 2.01 \pm .01$, $\gamma_{Li} = 2.04 \pm .01$. It is biaxial, negative with a medium axial angle. Other optical properties have also been determined. It was found that $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ and $2CaO \cdot Fe_2O$ form a complete series of solid solutions. The melting relations and optical properties of these solid solutions have been determined. $CaO \cdot Al_2O_3$ and $CaO \cdot Fe_2O_3$ form limited solid solutions with each other. $CaO \cdot Al_2O_3$ takes up about 15% of $CaO \cdot Fe_2O_3$ in solid solution and $CaO \cdot Fe_2O_3$ takes up about 10% $CaO \cdot Al_2O_3$. With this solid solution there is an increase in the indices of refraction of $CaO \cdot Al_2O_3$ and a decrease in those of $CaO \cdot Fe_2O_3$. It was observed that the indices of refraction of $3CaO \cdot Al_2O_3$ and $5CaO \cdot 3Al_2O_3$ were higher in this system than in the binary system and it is explained that none of the binary compounds of CaO with Al_2O_3 or Fe_2O_3 are found as the pure compounds in ternary system. The exact amount and nature of all the solid solutions formed within this system have not fully been determined. The fields in which CaO, $3CaO \cdot Al_2O_3$, $5CaO \cdot 3Al_2O_3$, $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ and solid solutions of $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ and $2CaO \cdot Fe_2O_3$ separate as primary phases from the ternary melts are shown diagrammatically. R.J.P.

Characterization of clay. A. F. JOSEPH. *Brit. Clayworker*, **36** [429], 311–12 (1928).—One of the difficulties in passing from the work of soils to that on ceramic clays is the absence of a common definition of "clay." Most soil chemists restrict this term to that fraction of the raw material of which the largest particles are 0.002 mm. It is fairly certain that the real claylike properties of importance, such as plasticity, shrinkage, and water retaining capacity, are mainly confined to that fraction, and there is an obvious advantage in studying materials which are as homogeneous as possible. The following table shows the range in mechanical composition for a number of clays:

Particles less than 0.002 mm. (%)	Mechanical composition		Sample
	0.2–0.02 mm.	0.02–0.002 mm.	
20.2	5.5	74.2	1
36.6	2.6	60.8	2
28.2	10.1	61.7	3
26.3	9.9	63.8	4
12.8	14.7	72.5	5
31.8	7.2	61.0	6
89.8	3.9	6.3	7
60.9	21.0	16.9	8
63.2	27.1	8.3	9
28.0	6.4	65.6	10
26.8	9.4	63.8	11
20.4	3.7	65.9	12

The range in proportion of true "clay" is considerable, varying from 12–90%, and if the nature of this fine fraction did not vary in materials of different origin, the properties of the whole product would probably depend on the amount of 0.002 separate. The

fine fractions of Nos. 5 and 6 are not very different in their properties or compositions, so that No. 6 containing 2.5 times as much clay as No. 5 should be more plastic and this is the report of the producers. Numbers 3 and 4 closely resemble one another in mechanical composition, but No. 3 is very much more plastic than No. 4 so that the reason for plasticity must be sought in the nature and not in the amount of the "clay" fraction. Results obtained by chemical analysis on the finest portions of clays show conclusively that there is a very close relationship between the chemical composition of the "clay" and its physical properties, which can be generalized by the statement that the molecular ratio of silica to alumina is related to claylike properties. The higher this ratio is, the more highly developed are such properties as imbibitional power for water, heat of wetting, shrinkage, tensile strength and absorptive power for vapors and dyes; with low values of this ratio, claylike properties are exhibited to only a small degree, and it appears likely that with a ratio of 2.0 (the ratio for kaolinite) they would be entirely absent. J. prefers the "imbibitional water" capacity for determining the plasticity. This is a measure of the volume of water retained by the material after centrifugal draining under standard conditions less the interstitial space, the latter being measured by some inactive liquid (xylene) retained under the same conditions. The following list gives the chemical composition and imbibitional water capacity of six "clay" separates together with three typical "clays" of different origin:

Properties of clay fraction (per cent)					
SiO_2	Al_2O_3	Na_2O+K_2O	Ratio SiO_2/Al_2O_3	Imbibitional water	Description
46.6	38.5	0.90	2.05	0	Weak clay
47.0	38.7	1.20	2.06	0	Potting "
46.8	37.6	0.88	2.11	5	Weak "
47.8	37.3	1.07	2.18	7	" "
47.6	36.3	2.16	2.23	19	Strong "
49.3	31.4	1.12	2.66	44	Ball "
44.6	20.0	1.53	3.77	79	Alluvial "
46.7	20.2	1.02	3.90	101	Plastic soil
68.3	16.6	1.66	6.96	261	Bentonite

This list shows that clay properties are associated with a high silica-alumina ratio. J. also discusses the assumption that the degree of plasticity of clays is due to amount of extremely fine or colloidal matter present and shows the possibility of error in this assumption. R.A.H.

Consumption of reagents used in flotation, 1926. THOMAS VARLEY. Bur. Mines, Report of Invest., No. 2852. 12 pp. (1928). R.A.H.

Heavy liquids for mineralogical analyses. JOHN D. SULLIVAN. Bur. Mines, *Tech. Paper*, No. 381, 26 pp. (1927).—The purpose of the investigation described was to develop a series of heavy liquids for use in mineralogical analyses, to get a series of cheap liquids that would enable one to separate by means of the sink and float method the heavier mineral particles from the gangue, and, if possible, to separate the various minerals from one another. The investigation has consisted largely in a study of the liquids already in use and the development of suitable liquids other than those. The price of the reagent, its fluidity, transparency, ease of preparation and recovery, and ease of handling have been taken into account. A table is included giving the liquids which have been experimented with and which are based on the foregoing considerations. R.A.H.

Thermal expansion of feldspar. ANON. Bur. Stand., *Tech. News Bull.*, No. 129, pp. 4–5 (1928).—This report is a summary of the study of the thermal expansion of partially and completely fused feldspars fired to cones 4, 8, 10, 12, 13, and 14. The data obtained show (1) that the expansion proceeds quite regularly until a temperature

of 575°C is reached when the expansion increases rapidly due to the inversion of quartz; (2) that the expansion of a feldspar fired below cone 8 is low, becomes normal at cone 8, and drops again when firing temperature rises above cone 8; (3) that the silica content appears to have more influence upon the expansion of partially and completely fused feldspars than the Na_2O or K_2O content or the fineness of the grind. In addition a table is given which shows the percentage of linear expansion of the partially and completely fused feldspars at 560°C together with their softening points and percentage of free silica content. R.A.H.

Thermal expansion of beryllium and aluminum-beryllium alloys. PETER HIDNERT AND W. T. SWEENEY. Bur. Stand., *Sci. Paper*, **22** [565], 533–45 (1927).—The investigation described was undertaken because no data on the thermal expansion of beryllium or its alloys were available. Results are given on the linear thermal expansion of beryllium and 5 aluminum beryllium alloys. Expansion determinations were made over various temperature ranges between −120 and +700°C on a sample of beryllium, and between room temperature and 500°C on the alloys. The average coefficient of expansion of beryllium is 12.3×10^{-6} per degree centigrade between 20 and 100°C. The coefficients of expansion of the aluminum-beryllium alloys decrease with increase in the beryllium content. R.A.H.

Developments and applications of the electric telemeter. O. S. PETERS. *Proc. A.S.T.M.*, **27** [2], 522–33 (1927).—In 1923, an electric telemeter, developed at the U. S. Bureau of Standards was described before the A.S.T.M. Since that time progress has been made in the further development and in practical applications of this instrument. Photographic records are included from apparatus devised to produce mechanical displacements of widely different frequencies which are shown on the same film with their reproduction by the telemeter. These serve to indicate the accuracy of the reproduction, and also to point out errors which may arise because of inertia effects in measuring strains due to rapidly changing loads. There are also shown a number of telemeter records from different applications such as impact measurements on street-car rails and acceleration stresses in coal-mine hoisting cable. The telemeter cartridge used for measuring strains in mass concrete at the Stevenson Creek Arch Dam and at other places is also described. R.A.H.

Shrinkage computations. JOSEF WOLF. *Sprechsaal*, **60** [48], 889–91, [49], 917–19 (1927).—The total shrinkage of a body equals the sum of the drying and firing shrinkage. A discussion, with the presentation of a large amount of data, on why this supposition must result in error due to the method of computation used by the worker. R.A.H.

Ceramic raw materials and their colors. FRITZ KÄSTNER. *Sprechsaal*, **60** [49], 915–17 (1927).—A discussion of the causes of the colors in ceramic materials, especially quartz, quartz sand, kaolin, and clay and how far one is entitled to judge the value of the material from its color and conclusions as to possibilities of their uses. R.A.H.

Plasticity and bonding power of clay. VAN NIEUWENBURG. *Sprechsaal*, **60** [51], 958–59 (1927).—Synopsis of an article which appeared in *Klei* (Holland). R.A.H.

Clay and water: colloidochemistry review. RAPHAEL E. LIESEGANG. *Sprechsaal*, **60** [52], 990–91 (1927).—A short discussion on what has been accomplished in this field. R.A.H.

Future problems in the investigation of silicates. WILHELM EITEL. *Sprechsaal*, **60** [52], 988–89 (1927).—A discussion of the complexities of silicate investigations and the possibilities in the use of the Röntgen rays. R.A.H.

Cohesion and solution. W. F. LLOYD. *Chem. and Ind.*, **47**, 7 (1928).—Experiments were made with a view to determine whether there is any relation between hardness of crystals and their rate of solubility in water. Hardness was measured by weighing the

amount of crystal ground away by a bit after a given number of turns. The results of the experiment were inconclusive. H.H.S.

Atomic weight revisions. ANON. *Chem. and Ind.*, **47**, 74 (1928).—According to the report of the German Atomic Weights Commission, the following changes have been made: argon 39.94 (from 39.88), Ti 47.90 (48.1), Yt 88.93 (89.0). H.H.S.

Solubilities of salts. J. A. V. BUTLER. *Chem. and Ind.*, **47**, 60–62 (1928).—Solubility depends on the opposing effects of two fundamental quantities: the lattice energy of the solid, and the heats of hydration of the gaseous ions. The net work done in passing from the solid into the interior of the solution is the heat absorbed on solution. One would therefore expect a parallelism between heat of solution (Q) and solubility (S), although the latter will numerically be influenced by factors (*e.g.*, mass configuration) which determine the motions of ions under given forces. Data are given which show that, in series of similar salts, there is a very close parallelism between S and Q, but that the parallelism does not extend to unlike salts. H.H.S.

A mode of application of Tammann's thermoanalysis to reactions between solid phases. J. GUILLISSEN. *Bull. sci. acad. roy. Belg.*, **13**, 233–38 (1927).—Tammann's method consists in determining the heating curve of a mixture of the solid reagents, then determining the curve for the product of the reaction. The point at which the curves cease to coincide is taken as the reaction temperature. The method can be rendered more sensitive if the curve temperature *vs.* time is replaced by the curve temperature *vs.* temperature difference, *i.e.*, $f(\theta, \theta-\theta')=0$. The double galvanometer of Le Chatelier-Saladin may be used for that purpose. The reactions $PbO+CuSO_4 \rightarrow PbSO_4+CuO$ and $PbO+MoO_3 \rightarrow PbMoO_4$ have been used to test the method. The results duplicate those obtained by Tammann. The production of Fe_2O_4Ba is obtained at about 830° from Fe_2O_3 and $BaCO_3$, at about 300° from Fe_2O_3 and BaO. An experiment with Fe_2O_3 and $CaCO_3$ was not conclusive. (*C. A.*)

The temperature of formation of the zinc ferrite from its solid constituents. J. GUILLISSEN AND RICHARD. *Bull. sci. acad. roy. Belg.*, **13**, 238–40 (1927).—Solid Fe_2O_3 and ZnO react at about 620–50°, yielding Zn ferrite. NH_4OH and NH_4Cl dissolve 34% of the mixture Fe_2O_3 and ZnO. After heating they dissolve only 8%. (*C. A.*)

Rapid method for determining silica, alumina, lime, and magnesia in low-manganese iron ores. R. P. HUDSON. *Chemist-Analyst*, **16** [2], 4 (1927).—The method follows conventional lines of common practice precipitating Al in the filtrate from the SiO_2 as $AlPO_4$ by $NaNH_4HPO_4$ and $Na_2S_2O_3$ and determining CaO and MgO in an aliquot part of the filtrate from this precipitation. A correction is made for Mn in the precipitate of $MgNH_4PO_4$. (*C. A.*)

Rapid determination of calcium and magnesium. C. J. SCHOLLENBERGER. *Chemist-Analyst*, **16** [2], 6–7 (1927).—In the filtrate from the NH_4OH precipitation of the Fe and Al, the Ca is precipitated by oxalic acid and then, without filtering, the Mg is precipitated as $MgNH_4AsO_4$. The precipitate of CaC_2O_4 and $MgNH_4AsO_4$ is dissolved in dilute H_2SO_4 and the oxalate is titrated with $KMnO_4$. Then the As is reduced by KI to the tervalent condition and oxidized iodometrically in the presence of $NaHCO_3$. (*C. A.*)

Determination of potassium and sodium in the presence of one another. ARTHUR MEYER. *Chem.-Ztg.*, **51**, 778 (1927).—A rediscovery of the well-known indirect methods of titrating the chlorides in a mixture of NaCl or KCl or determining SO_4^{--} gravimetrically after weighing Na_2SO_4 and K_2SO_4. (*C. A.*)

The adsorption of ions by glass. H. DEVAUX AND E. AUBEL. *Compt. rend.*, **184**, 601 (1927).—Glass wool which has a surface area of 18,605 $cm.^2$ is packed into a tube 14 mm. in diameter and 470 mm. long. A solution containing 0.5 mg. Ca as sulphate is poured down this. When this is washed with distilled water, no precipitate is obtained on addition of oxalate to the wash liquor. When further calcium salt is poured

through the tube, the adsorption is incomplete. The adsorbed calcium can be replaced by potassium or sodium when the chlorides of these metals are poured through. This occurs also with H, NH_4, and even with quinine salts, but calcium can replace these. When the glass has been decalcified by K_2SO_4 and washed, it is found that when treated with the lime solution it adsorbs a layer of calcium ions, approximately monomolecular, instantaneously. After prolonged treatment with HCl, K_2SO_4, etc., the glass adsorbs a layer of calcium ions several molecules thick. Such adsorption is a function of time. An adsorption-time curve is shown. It is concluded that in such a case the glass behaved as a gel. (*J.S.G.T.*)

Note on the production of fluorite in the electric furnace. D. C. STOCKBARGER. *Jour. Opt. Soc. Amer.*, **14,** 448 (1927).—Experiments were made to produce crystals of fluorite which are highly transparent to ultra-violet rays. Pure calcium fluoride was fused in a vertical electric furnace. Crystals up to 1/8-inch diameter were obtained. (*J.S.G.T.*)

Zirconium ores. GAETANO CASTELLI. *Rass. min. met. chim.*, **67,** 1–4 (1927).—A description of the occurrence and uses of Zr ores and the properties and uses of Zr, with 12 references. (*C. A.*)

Gravimetric determination of calcium. A. FRANKE AND R. DWORZAK. *Z. anal. Chem.*, **72,** 129–34 (1927).—The determination of Ca as CaO, $CaSO_4$, or CaC_2O_4 gives good results in the hands of the capable chemist. When the determination as CaO is chosen, the use of P_2O_5 in the desiccator is advisable because moisture is slowly absorbed when CaO is dried over $CaCl_2$. Drying the precipitate at 105° for 5 hrs. gives results that are so good that it seems strange this method has not met with a more friendly reception. (*C. A.*)

Determination of sulphur present as sulphide in glass. H. HEINRICHS. *Z. anorg. Chem.*, **166,** 299–305 (1927).—Sulphides in glass may be determined by warming 1 g. of the finely-powdered glass with a mixture of 5 cc. of water, 25 cc. of dilute (1:1) hydrochloric acid, and 5 cc. of 48% hydrofluoric acid in an apparatus of sulphide-free glass, and passing the hydrogen sulphide evolved into 0.01 *N*-iodine solution. Before the acid is added, the air is displaced from the apparatus with a stream of carbon dioxide, which is continued until all the hydrogen sulphide has been expelled. As, in general, the amount of sulphide present is very small, it is desirable to make a separate qualitative test in which the hydrogen sulphide is detected with a lead acetate paper. Analyses made in this way with various glasses show that the effect of a sulphide on the color of glass is very much greater than that of an equal amount of the corresponding oxide. (*B.C.A.*)

Ion exchange of zeolitic silicates with hydrolytically dissociated salts. I. Experiments with silicates. H. KAPPEN AND F. RUNG. *Z. Planzenernähr. Düngung Bodenk.*, **A8,** 345–73 (1927).—The authors attempted to prepare the Fe, Al, and Cr permutites by repeatedly treating Na permutite with salts of the metals. After subsequent washing of the permutites and treating with a *N* solution of KCl, it was shown that a very small exchange acidity was developed, which in every instance was attributed to the Al ion. There was a decomposition of the permutites by the metal salt solutions. The Fe^{+++} salt was precipitated in the capillaries of the permutite as the hydroxide. The authors were successful in preparing Fe^{++}, Cu, and Zn permutites which showed the exchange reaction with a KCl solution. The acidity developed in the KCl solutions was accounted for by the metal which entered the permutite. By treating the permutite with acids the Al of the permutite was brought into the replaceable form. Upon continued treatment the Al of the permutite was almost entirely removed and the exchange acidity was decreased. K. and R. maintain that there is no evidence of the replacement of the H-ion in any of their permutites. (*C. A.*)

BOOKS

A System of Qualitative Analysis for the Rare Elements. ARTHUR A. NOYES AND WILLIAM C. BRAY. 536 pp. The Macmillan Co. New York, 1927. Price $5.00. Reviewed in *Ind. Eng. Chem.*, **20** [1], 106 (1928). R.J.P.

Methods of the Chemists of the U. S. Steel Corporation for the Sampling and Analysis of Gases. 3rd ed. 187 pp. Carnegie Steel Co., Pittsburgh, 1927. Price $2.00. Reviewed in *Ind. Eng. Chem.*, **20** [1], 104 (1928). R.J.P.

Contemporary Developments in Chemistry. (Lectures by Eminent Chemists.) Columbia Univ. Press. N. Y., 1927. 464 pp. Illustrated. 23.5 x 16 cm. Price $11.00. Reviewed in *Jour. Amer. Chem. Soc.*, **49** [12], 3196 (1927).—This is a collection of 25 lectures delivered at Columbia Univ. in a special course given during the Summer Session of 1926, on the occasion of the opening of the Chandler Laboratories. R.J.P.

Standards and Tests for Reagent and C. P. Chemicals. BENJAMIN L. MURRAY. 2nd ed., revised and enlarged. xiii+560 pp. D. Van Nostrand Co., Inc., N. Y., 1927. Price $5.00. Reviewed in *Ind. Eng. Chem.*, **19** [12], 1374 (1927). R.J.P.

PATENT

Silicates. A. J. HADDAN. Brit. 268,011, Dec. 18, 1925. A voluminous, almost gelatinous mass of hydrated calcium metasilicate is produced by treating finely ground diatomaceous earth with lime, or with the oxides or hydroxides of magnesium, strontium, or barium, in the presence of water, with or without heating. The product is dried and pulverized. (*T.E.C.S.*)

General

Management vs. technical knowledge: which is more important? EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [2], 25–26 (1928).—The importance of knowledge of scientific facts and their relation to production problems is discussed. Due to changing conditions production and management skill are of equal importance. The effect of difference in grade of products of competitors on the consumer's reaction to all such products is pointed out. The causes of trade handicaps are mentioned. E.J.V.

Research and technology. ANON. *Brick Clay Rec.*, **71** [13], 937–38 (1927).—A brief report of the American Refractories Institute meeting at St. Louis, Mo., December 6 and 7, 1927. Papers read included: "History and Status of the Refractories Industry," by J. D. Ramsay; "German Laboratory Practice," by A. P. Green; "Some Special Refractories in the Experimental Stage," by G. A. Bole; "Developments in Burned Dolomite as a Stable Basic Refractory," by M. E. Holmes and G. A. Bole; and "Dry Grinding of Refractories," by J. M. Gallagher. Discussions of laboratory slag tests, spalling, drying, grinding, tunnel kilns, and fuel consumption were held. E.J.V.

Common Brick Manufacturers' Association convention. ANON. *Brick Clay Rec.*, **72** [2], 102; [3], 188–91 (1928); *Clay-Worker*, **89** [2], 124–26 (1928).—Some of the subjects discussed at the 10th convention held in Washington, D. C., February 13–17 are (1) how to stem the importations of foreign brick, (2) more effective salesmanship against substitutes, (3) research work at the Bureau of Standards, (4) the outlook for 1928. E.J.V.

Annual meeting of New Jersey Clay Workers. ANON. *Clay-Worker*, **89** [2], 126 (1928).—A brief report of the meeting held at New Brunswick, N. J. Addresses included papers on: "Firing," by D. P. Forst; "Notes on the Production of Cream-Colored Bodies," by George H. Brown; "Effect of Moisture vs. Pressure in the Production of Dust-Proof Wares," by E. C. Henry; "Progress Report on Kiln Slab Investigation," by F. B. Allen; "Refractory Cements," by C. F. Geiger; and a talk on the Ceramists' Tour Abroad, by R. C. Purdy. E.J.V.

Paving Brick Manufacturers' Association Meeting. ANON. *Clay-Worker*, **89** [2], 137–41 (1928); *Brick Clay Rec.*, **72** [3], 182–85 (1928).—A report of the convention held in Chicago, January 25 and 26. Papers on road construction, particle sizing of paving brick, selling, maintenance, and types of bases for the laying of brick pavements were read and discussed. E.J.V.

Industrial research. ANON. *Eng. News-Rec.*, **99** [25], 994 (1927).—Industrial research by corporations and by the federal government amounts to $200,000,000 annually, of which industry spends $2.00 for each $1.00 spent by the government. Industries whose research expenditures were largest 5 years ago are those which have scored the greatest relative growth since then. G.W.W.

The engineering year in review and prospect. EDITORIAL. *Eng. News-Rec.*, **100** [2], 49–56 (1927).—A review of the past year as seen from the vantage point of engineering thought. G.W.W.

High temperature insulation. ANON. *Blast Fur. Steel Plant*, **16** [1], 80–81 (1928).—Insulation is now being successfully applied to practically all types of equipment, including (1) boilers, (2) many types of furnaces, (3) core, coke, baking, and enamel-drying ovens, (4) oil stills and storage tanks, (5) water-gas sets and coal-gas retorts, (6) hot-blast stoves and mains, (7) soaking pits, (8) brick, lime, and cement kilns, (9) glass-making equipment, etc. A rather new application of insulation, but one which is now being employed satisfactorily by a number of plants, is the insulation of the blast-furnace stack. A coarsely-ground insulating powder is used, packed between the lining and the shell of the stack, above the mantle. F.P.H.

National Research Council information. ANON. *Ceram. Ind.*, **10** [2], 204–206 (1928).—The July *Bulletin* of the National Research Council has an exceedingly informative list of the industrial research laboratories of the U. S. and the subjects upon which they are working. Much information regarding the staff and amount of time expended upon research by the various companies is also given.

University of Michigan ceramic course. ANON. *Ceram. Ind.*, **10** [2], 208 (1928).—The Univ. of Michigan has issued an announcement of the courses in chemical engineering for graduate work. A new engineering building has been built which is said to contain excellent laboratory facilities. A ceramic course is scheduled. F.P.H.

Superex, a new block insulating material. ANON. *Ceram. Ind.*, **10** [2], 226 (1928).—The Johns-Manville Corp. is furnishing a block-insulating material called Superex that should be of special interest to designing and operating engineers in the ceramic industry. Superex is composed basically of diatomaceous earth and asbestos fiber, molded into block form in such a manner that it is homogeneous throughout, without lines of stratification or planes of weakness. This produces an insulation that is said to be exceptionally well adapted for temperature conditions up to 1500°F. It has low thermal conductivity and although weighing only approximately 24 lbs. per cu. ft. has satisfactory mechanical strength. It will safely withstand temperatures up to 1500°F with negligible shrinkage and because of the temperature drop in the brick work of the furnace wall it is adaptable to the insulation of furnaces at temperatures far higher than 1500°F. An important feature in connection with this material is that it is furnished in flat or curved blocks 6 in. by 36 in. in size and thickness up to 4 in. This reduces the number of joints and the labor of application as compared with insulation in smaller units. Insulation in block form, such as Superex, when used in thicknesses of 3 in. or over, is applied in 2 layers of equal thickness with all joints broken. This elimination of through joints not only reduces the heat loss which would occur through these joints to a minimum, but tends to cut down air infiltration through various cracks and openings in the brick work, it is claimed. F.P.H.

Developments in the Benson high pressure steam generator. ANON. *Eng. Boiler House Rev.*, **41** [2], 61 (1927); *Feuerungstechnik*, **15** [24], 288 (1927). F.P.H.

Boiler house developments in the U. S. ANON. *Eng. Boiler House Rev.*, **41** [2], 66 (1927); *Feuerungstechnik*, **15** [24], 288 (1927). F.P.H.

The Hagen steam separator. O'BREEN. *Eng. Boiler House Rev.*, **41** [2], 78 (1927); *Feuerungstechnik*, **15** [24], 288 (1927). F.P.H.

Formation of fissures in boiler plates. E. SPRINGORUM. *Feuerungstechnik*, **15** [23], 265–68 (1927). F.P.H.

Design of an air preheater. WILHELM GUMZ. *Feuerungstechnik*, **16** [1], 1–5 (1928). —The design of an air preheater for a 500 m.² boiler is considered. The temperature of the air is changed from 20–200°C. A general relation between the heating surface, gas and air velocity, and the length of the gas passage is derived. F.P.H.

Automatic regulation of boiler feed. PRANTNER. *Wärme*, **50** [26], 470 (1927); *Feuerungstechnik*, **15** [23], 276 (1927). F.P.H.

Notable events of 1927. ANON. *Chem. Age*, **17**, 591 (1927).—From the British point of view, 1927 was marked by the formation of Imperial Chemical Industries, the inauguration of the International Superphosphate Mfrs. Assn. in London, the opening of new laboratories of the Paint, Color, and Varnish Research Assn., the amalgamation of the Institute of Fuel Technologists with the Institute of Fuel Economy Engineers to form the Institute of Fuel, and the concession to exploit the mineral resources of the the Dead Sea. The field of attention in the future is that of fuel technology. H.H.S.

The seven lamps of chemical enterprise. C. J. T. CRONSHAW. *Chemical Markets*, **22**, 47–50 (1928).—The seven lamps are: Research, Precision, Service, Unity, Judgment, Leadership, Vision. H.H.S.

List of permissible mining equipment. ANON. Bur. Mines, *Information Circ.*, No. 6047, 10 pp. (1928).—A list of equipment used in mining which has passed certain tests prescribed by the Bureau. R.A.H.

Blasting to lessen boulders in hard-ore stopes. E. D. GARDNER AND S. P. HOWELL. Bur. Mines, *Tech. Paper*, No. 383, 23 pp. (1927).—Were it not for the boulders many deposits of hard ore could be mined by a method that would permit efficient handling of the broken material by mechanical devices, with consequent saving of labor. Even if no shoveling is required in the stopes, the formation of boulders is a series disadvantage. In this work the methods of mining and drilling were considered fixed and the investigators have sought a solution of the boulder problem by the use of improved blasting practices and a better selection of explosives. R.A.H.

Annual report of the Director of the Bureau of Mines. ANON. 48 pp.—The report covers the fiscal year ending June 30, 1927, and refers briefly to the various projects included in this Bureau's activities and what has been accomplished during the year. R.A.H.

Artificial porosity in ceramic bodies. JULIUS MEYER AND KURT PUKALL. *Sprechsaal*, **60** [48], 887–88 (1927).—The methods used by M. and K. for increasing the porosity of ceramic bodies is based on chemical reactions taking place between either the moisture in the plastic mass or constituents of the clay and finely pulverized metals which are added. Such a reaction causes the evolution of gases which tend to increase the porosity of the body. Metals experimented with are aluminum, calcium, magnesium, and silicon. R.A.H.

Technical press, technical school, and ceramic information. E. BERDEL. *Sprechsaal*, **60** [52], 1013–14 (1927). R.A.H.

BOOK

Modern Blasting in Quarries and Open Pits. J. BARAB. Published by Hercules Powder Co., Wilmington, Del. 1927. 169 pp. $3. *Min. and Met.*, **9** [254], 95 (1928). F.P.H.

PATENT

Rustless alloy steel. JOHN THOMAS WHITELEY. U. S. 1,647,491, Nov. 1, 1927. An alloy steel comprising chromium 8.75%, nickel 3%, copper 1%, silicon 1.5%, carbon 0.2%, zirconium 0.75%, titanium 0.5%, with the remainder iron.

Book Reviews

Productivity of Labor in the Glass Industry. BORIS STERN. U. S. Bureau of Labor Statistics, *Bull.*, No. 441 (1927).—More than 200 pages, 34 illustrations, and 50 tables are included in this *Bulletin* which is of interest to all engaged in the glass industry. Each of the four chapters is devoted to a different branch of the industry: (1) Bottles and Jars, (2) Pressed and Blown Ware, (3) Window Glass, and (4) Plate Glass.

Chapter II, "Pressed and Blown Ware," does not relate to what a manufacturer calls "press and blow" work, as might be assumed. This chapter discusses pressed ware and thin blown ware, mostly paste mold.

Under the heading "Development of Machinery in the Industry" will be found a very brief review of the early history in the various lines. The description of the general operation employed in the various branches under discussion, is exceptionally good and should prove valuable for educational purposes. The various tables are arranged to show the rate of production, cost by hand and on various types of machines, and many other highly interesting statistics, in connection with both hand and automatic production. It will be surprising if some specialists, in the various branches of the industry, do not criticize some of the figures given, but in such a large compilation, particularly when it is well known that the records kept by many manufacturers, especially a few years ago, were very crude and incomplete, there is sure to be some difference in opinion.

While there are occasional statements that will be questioned by professional glass men, these do not detract from the value of the work as a whole, which is not intended to be a manual of technical glass working, but rather a comparison of production statistics.

It is noted that the Bicheroux process is not included in the chapter on plate glass. While this process is not yet in extensive use in this country, it is of increasing importance.

This *Bulletin* should be in the hands of all glass manufacturers, perhaps more particularly those who still employ hand labor where machinery might be used. It is well worth the effort which has been expended in its production, simply as a record of the changes brought about by the use of automatic machinery, and it is hoped that the Bureau of Labor Statistics will continue the good work which they have started. The last government publication approaching this *Bulletin* in scope, was "The Glass Industry," put out by the Department of Commerce, Bureau of Foreign and Domestic Relations, in 1917. This early publication was considerably different in character, but some of the subject matter was a close parallel to the present *Bulletin*.

This *Bulletin*, being a government publication, is not advertised, but copies may be obtained at forty cents each by addressing the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. It should be noted that postage stamps will not be accepted in payment. R.A.H.

The Production of Clinkers, Especially Cement Clinker. PAUL JÜRGEL. *Tonind. Ztg.*, Berlin NW 21. 1927. 42 pp. 3.50 RM.—The work of Jürgel is always distinguished by its clarity, genuine knowledge, and above all, by its practical utility. Not only is the explanation of the ware itself clear, exhaustive, and practical, but also the portrayal of the preparation and shaping. There follows an instructive chapter on drying and firing of clinker, wherein all modern practice and methods are most carefully

considered. The sorting and transporting of the clinker is exhaustively described. This valuable booklet well illustrated can be recommended to all ceramists, whether in coarse or fine ceramic work. E.J.V.

Die Feinkeramik. Compiled by W. HUTH. Published by *Keramische Rundschau*, Berlin. Price (bound) RM 15. The handbook begins with a discussion of the meaning of the word "ceramic," by H. Hecht, who opposes the American suggestion to include in the term glass, cement, and other kindred products. The learned doctor, supporting his arguments with a wealth of classical quotations and appealing to English and French technical works and to general tariff classifications, proposes to include only articles fashioned from plastic clay, dried, and hardened by firing, and sets out a fairly reasonable classification on this basis. A second section deals with the raw materials of the fine pottery industry, kaolin, clay, quartz, and feldspar. Directories are then given of the German firms engaged in the various branches, with their organizations, societies, and unions. Import, export, and tariff particulars for Germany and other countries are supplied, with a formidable list of technical schools, etc., for the industry and a comprehensive index of German pottery trademarks. E.J.V.

CERAMISTS' TOUR ABROAD

May 19

Your Last Chance to Make Reservations

S. S. "Tuscania"

April 1, 1928

Dear Readers:

May nineteenth, just a few weeks away, the S.S. Tuscania will be sailing from New York harbor carrying many of your friends and fellow ceramists to Europe. Here they will view what other countries have done in the ceramic industries, the equipment of their factories, the results of their labors.

The places you have read about all your life are on the itinerary of the Ceramists' Tour Abroad. Your friends as well as your competitors will come back July fifth with increased information about ceramic manufacture and a broader culture.

Can you afford to be left behind? The complete cost of the tour is $900 and you can make your reservation or get more information by addressing the Ceramists' Tour Department, 25 Broadway, New York City. Space on the steamer is rapidly being sold out. An early reservation is imperative.

We hope to see you on board the S.S. Tuscania, May nineteenth.

Sincerely yours,

The American Ceramic Society

Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering COLUMBUS, OHIO

Founded 1895

Curriculum—Ceramic engineering and technology. Advanced research in cooperation with State owned plants and Federal Government.

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Founded 1900

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering URBANA, ILLINOIS

Founded 1905

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products.

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Founded 1906

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate.

THREE INSTRUCTORS *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Founded 1910

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering SEATTLE, WASHINGTON

Founded 1918

Curriculum—General ceramic engineering with research in ceramics and non-metallics.

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Founded 1921

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Founded 1923

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Instructor:* GEO. J. BAIR

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT

Founded 1923

Curriculum—Ceramic Technology and Engineering

TWO INSTRUCTORS *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—students selection of ceramics includes chemical and engineering principles applied to ceramic manufacture.

TWO INSTRUCTORS AND TWO ASSISTANTS *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827. Department of Metallurgy, Ceramic Division, 1925.

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Founded 1926

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering

Head of Department: J. W. WHITTEMORE

THE OHIO STATE UNIVERSITY

Department of Fine Arts COLUMBUS, OHIO

Founded 1927

Curriculum—ceramic art and technology to train artists for the ceramic industries.

THIRTEEN INSTRUCTORS *Head of Department:* JAMES R. HOPKINS

ZIRCONIUM

LIKE Vanadium, Molybdenum, Tungsten, Titanium and several other elements that were laboratory curiosities a few years ago, Zirconium has been admitted to the family of industrial necessities, and the production of its compounds on a tonnage basis is as definite and accurate as the production of any other chemical, commercial or C. P.

Opax is a registered trade mark name for a specific Zirconium Oxide, so constituted physically and chemically that it makes enamels and glazes white, produced by our patented processes from our own Florida sources of ore. Opax is a definite chemical compound, carefully controlled and constant. The experience of the foremost enamelers during the last five years gives it a place above all other opacifiers as to irreducibility, inertness, range of firing temperatures, opacity and economy. Containing no admixtures, it is absolutely non-poisonous.

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The Titanium Alloy Manufacturing Company

WORKS AT NIAGARA FALLS, N. Y.

Ceramic Materials Dept.: R. D. Landrum, General Manager

6007 Euclid Avenue, Cleveland, Ohio

BULLETIN
of the
AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 7 **April, 1928** **No. 4**

EDITORIAL

DESIGN IN PRINTED TABLE WARE[1]

BY CHARLES F. BINNS

Effort will be made to state the present situation as it appears to some of those who are interested in the success of American table ware both in satisfying the requirements of the best domestic use and in meeting the competition of foreign importations.

The bulk of the product consists of a so-called porcelain which is, in reality, a good grade of earthenware. This is made in white or ivory and is for the most part decorated with decalcomania prints in colors over the glaze. A large quantity of china is also made. Some of this is heavy for restaurant service, some is light and is used in good hotels as well as in households.

The problems of design seem to be in the quality of the prints. According to present information there are three manufacturing firms in this country who make some, if not all of the prints they need. All the others purchase their prints in sheets from the printing trade. Commercial printing is done in America, England, France, and Germany and sample books are submitted from which supplies are bought.[2]

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1928. (Art Division.)

[2] These statements are subject to criticism and correction. They are not authoritative but are based upon general information. Neither are they advanced in any captious spirit. The intent is simply to arrive at an understanding of the present situation.

American potters are confronted with a large importation of foreign table ware. Some of this appeals to the buyers of fine china and is found in the most exclusive stores. Some of it arrives in great bulk and at a price which cannot be profitaḥ ly met even under tariff protection as it now stands. There are, therefore, two foes to be met and they attack from opposite directions.

The inquiry may be made as to whether the manufacturers of domestic table ware are making any direct appeal to the public by way of advertising. It is common knowledge that retail dealers will buy the articles that are asked for by the public. Commodities of every kind, from breakfast food to brick are attractively set forth in the advertising pages of magazines and it is obvious that this would not be done unless there proved to be a sufficient return. Some of the journals published for the retail trade contain attractive colored illustrations of imported wares and occasionally of those of home manufacture. But these do not reach the buying public.

It is necessary, however, that the advertisers should have something distinctive to offer and this leads to the center and purpose of this inquiry. As far as present and perhaps imperfect information and observation go there is little or no inclination on the part of the producers or users of decalcomania prints to avail themselves of modern developments and ideas in applied design. Novelty consists in making four sprays of roses grow where three grew before, or in replacing a blue band with a green one. The salesman who sees that a pattern produced by a competitor is selling rather well, hurries home to his principal with the demand that "something like it but a little cheaper" shall be brought out at once. Nothwithstanding the belief that the people of this country lay strong claim to originality and regard tradition with contempt, it remains true that any successful endeavor will attract imitators as molasses lures flies.

An improvement in the situation might be found if manufacturers would employ a designer or invite and select submitted designs. A number of colored drawings properly displayed would, even if not actually carried out in plates, tend to broaden the views of the operators and the salesmen. Such drawings might be displayed in sample rooms and might stimulate prospective buyers to a different demand. The management could then decide whether or not production should be begun. There would not appear to be any reason why prints could not be made to order. They must first be designed anyway.

It is recognized that a procedure such as that suggested will be more difficult and more expensive than the existing plan of purchasing prints ready for use, but if the situation is as critical as it is supposed to be, no escape is possible without some trouble and expense.

But it may be argued that in order to prepare patterns which can be successfully reproduced the designer must be equipped with technical knowledge. This is true. He must be familiar with underglaze and overglaze ceramic colors, their possibilities and their limitations. He must know how they will behave when superimposed and how they will react with the glaze. This, however, is nothing more than any industrial designer must know in his own field. It applies to carpets and wall-papers, to oilcloths and draperies. All that is needed is that the manufacturers of table ware shall afford an opportunity.

That there is an abundant supply of young people trained in American art schools and earnestly seeking employment is proved by the amazing beauty of modern advertisement illustrations. Never before in human history has the art of color printing been brought to such perfection or used so extensively. If the people who direct campaigns of advertising can find employment for an army of trained designers, why cannot the potters do the same?

It may seem a bold thing to ask, but does not the whole question hinge upon contentment? If the makers of earthenware and china are satisfied to go on as they are going, if they are content with their present product, it would seem that little can be done. In that case, those who cry out for improved decorations must be, if not contented, at least quiescent, for they cannot force the situation. On the other hand, there is such a popular passion for beautiful things in the home that if these cannot be produced at home they will be found and purchased abroad.

The problem is by no means easy of solution. Here, if a designer is employed, his salary is "overhead," which must be kept to the minimum. There, in France, Germany, and England, the designer is an indispensable member of the staff. Often, indeed, he is multiplied into a group with well equipped studios on the scale of the drafting rooms in a terra cotta plant.

If a scheme like this can be adopted by even one American pottery there is no doubt whatever that the enterprise and originality which find their most congenial environment in the United States will speedily place the product in a proper and preëminent position which will yield "both fair renown and profit" to the undertaking. It will not be easy but it can be done.

New York State School of Clayworking and Ceramics
Alfred, N. Y.

PAPERS AND DISCUSSIONS

RECENT DEVELOPMENTS IN FIREBRICK TESTING

By E. E. Saunders

The present tendency to obtain a better price for quantity buying of materials has led buyers to purchase quantities considerably in excess of their present demands. This placing of unused material in stock for future consumption makes it impossible to change the grade of material should the first portion of the shipment prove unsatisfactory when placed under actual working conditions.

The past five years have witnessed a tendency toward increased care in the selection of refractories, which has necessitated general interest in the testing and development of refractories in the plant and in the laboratory. In no other field of ceramic endeavor has an appreciation of the scientific and technical research been as general and studies as broad as in the field of refractories.

One of the outstanding results of the ambition to develop fundamental information by studying closely the reactions going on under service conditions, and the result of these reactions has been the attempted laboratory duplication of service conditions by means of tests which have come to be designated by the term "simulated."

There is a danger that these simulated tests may be given such importance that their usefulness in insuring quality desired may be diminished. Simulated service tests may be written into specifications in the future which are not scientifically justified because they are only "factor of safety" tests at the best. If, for example, variations in resistance to spalling are caused by variations in thermal dilatation, elasticity, and pore structure, then the ideal specification should give limits for these properties.

In dealing with materials which cannot be accurately tested and whose every step in manufacture and firing can not be scientifically controlled, misunderstandings and misapplication of results must be expected if we continue to depend upon tests involving undeterminable factors.

To arrive at a real solution, it seems necessary to study individual clays and synthetic bodies composed of clays and other materials, the proportions, grain size, and inherent characteristics of which are known.

It is now common information that the differential thermal expansion between a grog and a clay (or clays) in the batch or between the clays of a batch may exceed the amount of deformation which the grog and the clays can undergo, producing a condition of interstructural stress which may be sufficient to seriously impair the strength or to cause rupture.

Also qualities of the clays used in manufacturing of brick may be sufficiently different to further changes in the brick after prolonged heating (such as the formation of glass) which would cause the expansion behavior of the heated end to be different from the cooler portions, and since the qualities of the individual clays are averaged (and often masked) it is important that the qualities of each low material be determined.

At the present time we are prone to permit the grain size of our materials and the blending of our clays to be influenced or even controlled by the materials available, the workability of the plastic mass, and the size of the shapes made from it. We may find it advisable in the future to sacrifice these conveniences and bring about desired workability and size by mechanical means, and in all probability influence beneficially the qualities of the bodies.

Another danger from the use of present test reports is the tendency to generalize these reports which are based upon a limited information. For example, a recent study of sagger clays by the Bureau of Standards establishes a fairly definite relation between porosity and the quenching temperature required to produce failure. The porosity varied from 10 to 40% and the quenching temperature from 500 to 800°C, but this was true only for those clays having a uniform rate of thermal expansion between 100 and 200°C. A number of tests having a limited application could be cited.

Another type of information, the importance of which is often stressed more than is justified, is the softening point of our refractory materials as expressed in cones. It appears that the majority of manufacturers, as well as technical men, feel that the cone softening point has no direct significance, but is necessarily tolerated by our lack of knowledge and lack of a better test. The cone softening point has no more real significance than has the average coefficient of thermal expansion. Both are only indicative.

The irregular curves obtained in testing brick for various characteristics such as load tests and average thermal expansion show that certain highly objectionable traits are brought out in refractories at certain temperatures which if they happen to be the working temperatures in which the brick are to be used would absolutely disqualify them, while were the working temperature to be higher or lower they would give excellent service.

The United States Government Master Specifications for Fireclay Brick stress the following tests in addition to size requirements and mechanical perfection of the product: (1) A definite maximum percentage of silica is specified for each class of brick; (2) a definite softening point; (3) a definite number of quenchings without failure. (A

brick is considered to have failed when the entire plane surface of the heated end has completely spalled away or when the structure of the brick has become so weakened that the end can be easily removed with the fingers.) Also, when specified, the brick must pass the Navy simulated service test.

The softening point specifications vary from cone 31 (3056°F) to cone 28 (2939°F), the quenchings from 15 to 3. In addition, certain classes require absorption after reheating shall not be less than 6% nor more than 16%, and in other classes a deformation under load shall not exceed 3 or 4%.

There is a tendency to employ these same tests for brick which are to be used in highly differing services. The American Refractories Institute in *Bulletin* No. 6 has worked out a table called the "Utility of Refractories" which gives the three major considerations as strength, resistance to destruction, and confinement of heat.

For all of the Northwest purposes the resistance to destruction is the principal determining factor, and this is divided up into the following classes: (1) abrasion, (2) slagging, (3) melting, (4) spalling. It is reasonable to expect that some brick will be better qualified for abrasive service, some to resist slagging, some for high temperature work, and some to resist the action of spalling.

Every manufacturer tries to believe and maintain that his brick will satisfy the requirements in each of these fields, which, of course, may be true if the requirements are low enough, but in the case of any one of the four qualifications being highly important, a certain brick might be best to use for that special purpose.

Below I shall attempt to outline as briefly as possible the method in which the standard tests are conducted and to point out in line with the discussion the limits of these tests and dangers to be encountered in too great reliability on their results.

Loading Test

The American Refractories Institute conducted a series of load tests at temperatures 1200, 1350, and 1450°C, and at each of these temperatures a pressure of 10, 25, and 40 lbs. per square inch was applied.

A special type of furnace was developed making it possible to test ten bricks at one time with the pressure applied horizontally. The data obtained at 1200° showed that no marked increase in compression was noted for increased loads. However, at 1350° the effect was more marked.

The results of these tests are only applicable when the construction contemplated is for division walls, crowns, and all positions where

soaking exists. When the furnace walls are heated only on one side, a temperature gradient exists through the wall, and the cooler portions of the refractory material are usually capable of supporting much higher loads than are normally encountered. A test of this statement showed that a 9 by 9 column tested at 1450° for seven hours showed 20% subsidence under 25 lbs. per square inch, when all four sides of the column are heated, and zero when only one side of the column was heated.

The Refractories Institute has drawn the following conclusions from its test:

(1) The load test should not be used for determining the suitability of a fireclay brick to meet a variety of service conditions.

(2) For selecting brick to support loads in furnace walls and arches, the load test should be run under the temperature and load conditions of actual use.

(3) Deformation is not apt to be an important cause for failure of fireclay brick in a furnace wall and will occur only when a high temperature is developed at a considerable depth in the wall.

Spalling Test

As a result of experimentation the preheated phase of the official spalling test, namely five hours at 1400°C has been eliminated and the official test now calls for the test to be conducted at 1350°C with water immersion of two inches. The A.S.T.M. adopted this test in June 1926. The requirements at present are 18 immersions before 20% in weight is lost for service where spalling is especially severe; 9 immersions for average requirements, and 5 where spalling occurs in a relatively unimportant degree.

The Institute also developed a service spalling test in which a test panel 15 by 27 was set up in suitable cement and held in place under pressure. A furnace was devised to make it possible to expeditiously place this panel in contact with heat at 1450°C, then subject them to an air blast, repeating this every ten minutes for 12 cycles.

It was found that preheating the test panels to 1550°C for seven hours caused cracking of the brick from shrinkage and vitrification. It is felt that this test will become standard and of great value in the hands of both manufacturer and consumer of refractory materials.

Slag Test

In most cases the surface of the brickwork in contact with the slag is much hotter than the inner portions. Consequently, as the slag penetrates a short distance it becomes more viscous at the lower temperature of the interior of the brick and finally solidifies. Further penetration is

impossible until the temperature equilibrium is disturbed. This is not destroyed until the diameter of the hearth is increased by the solvent action of the slag upon the refractory brick.

Slag action is, therefore, divided into two parts, penetration and solution. Penetration, however, is not necessarily important, for the penetrating slag may have no solvent effect whatsoever upon the brickwork. In any event, the action of the penetrating slag will always be less severe than that of the hotter, more concentrated slag at the surface. Furthermore, penetration will always cease as the cooler portions of the brickwork are reached.

On the other hand, the solvent action of the slag upon the fire brick is extremely important, for as it progresses new portions are exposed and complete destruction finally results. It is dependent only to a very slight extent upon penetration for, as has already been stated, the greatest solvent takes place at the hotter surface.

It is not surprising, therefore, that a slag penetration test is of slight practical value, for its results may be obscured by a high or low resistance to solvent action. On the other hand, a test designed to show resistance to chemical action should give information of practical value. Present information indicates that the fusion point method measures solvent action and, therefore, supplies an urgent need. This method is now being studied in detail and the results will be reported at an early date.

American Fire Brick Company
Spokane, Washington

ACTIVITIES OF THE SOCIETY

CERAMIC MANUFACTURING ABROAD

Last Call for Ceramic Tour Members

The whole-heartedness with which the ceramic manufacturers abroad have extended invitations to American ceramists to be guests in their works, at banquets, and at technical meetings as scheduled in the **Ceramists' Tour Abroad,** is unusual and most noteworthy. They ask nothing but that American ceramists come to them.

N. B. Jungeblut, Gen. Mgr. General Ceramics Co.

This tour provides the means and the schedule at a cost so low that several persons have expressed skepticism as to whether $900 will cover all transportation and hotel expenses.

Post tour trips are planned for those who wish to extend their stay abroad and to give more detailed study to ceramic production in Europe.

The friends abroad who are extending invitations represent all sorts of ceramic manufacturing. They are anxious to show their most modern methods of enameling iron and steel, of making building brick, building tile, terra cotta, floor and wall tile, refractories, pottery, porcelain, glass, and these in all varieties.

Optional plant inspections for each day are designed to suit the particular interests of each member of the tour. While it would profit the brick manufacturer to see the modern quantity production methods used in porcelain and glass factories, yet the six weeks abroad could be used exclusively in studying brick production in each of the countries covered by the tour.

Adalbert Zoellner, Marktredwitz, Director Porcelain Works, F. Thomas Inc., and President German Ceramic Society.

Sewer pipe, paving brick, and indeed all sorts of heavy clay ware plants have planned to be hosts to many American manufacturers of similar ware.

Refractory manufacturers are making special preparations with open plants and special meetings making this tour of the utmost value to the refractory manufacturers of America.

Stoneware, terra cotta, wall and floor tile manufacturers are especially urgent in their requests that Americans who are making like wares shall accept the hospitality which is being extended to members of this tour.

That the makers of fine clay wares for household use are collaborating to make this **Ceramic Tour** attractive is amply evidenced by the list of firms to be visited and by the photos of plants and plant officials. They have sent these pictures that their American cousins may the more fully realize the sincerity of the invitations they are extending.

If the American makers of wares in glass and in vitreous enameling have been skeptical of the wealth of opportunities to see these wares made abroad or skeptical

Lounge and music room—S. S. Tuscania.

Smoking room—S. S. Tuscania.

of the whole-heartedness of the invitations to come and be guests of the European glass and enameled ware manufacturers, the details of the itinerary should readily dispel such skepticism.

Here is an opportunity at the lowest possible cost under organized guidance to meet ceramic manufacturers collectively at special meetings, and individually at their plants.

W. Herman Zimmer, Director the Porcelain Works, Johann Haviland—Waldershof.

What of the delightful days in a palatial steamship going and coming? Lasting friendships will be made, experiences and observations will be leisurely exchanged, a lasting and inspiring fellowship will develop that will be productive of larger visions and of more definite knowledge of how to produce better quality at lower costs.

And fun? even this has been programmed and a variety provided that those of widely different natures may be equally entertained and relaxed. Definite rest periods at noted resorts and historical places are scheduled. A glance at the itinerary will show when and where these are provided.

And more fun:—did you ever travel with a variety of people all of whom you could respect and appreciate but who were so characteristically different individually that a most enjoyable party results. Jolly fun,—and none more completely satisfying than will be this **Ceramic Tour** party, for it is human nature to be sociable.

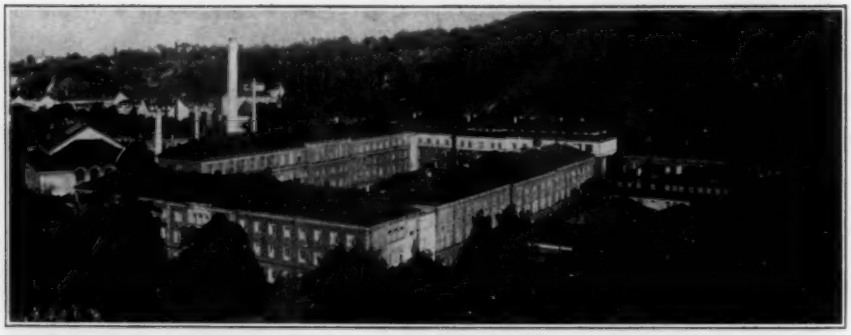
History—Romance—Thrills. These are sought by each of us and on this **Ceramists' Tour Abroad** will be met with in abundance.

Felix Singer, Technical Director General Ceramics Co.

Paris never ceases to hold the interest no matter how many times visited. It teems with history of the most romantic sort. In Paris are the wonderful boulevards, parks, mansions, monuments, and museums in which Americans have a national and personal interest.

Lucerne, one of nature's beauty spots; Mount Rigi, a mountain that inspires one to climb; the Rhine, a river so important in commerce, in peace, and in war, and so scenically beautiful as to be one of the best known even by those who have not traveled out of their home town. And Carlsbad; who has not the longing to roam the boardwalk and rest at the many resorts of Carlsbad, the famous play town. For its ceramic interest Carlsbad should be as well known as for its play places. It is the home of the Zettlitz kaolin, of famous Bohemian glass, pottery, and brick works.

Prague: the oldest of the European cities, the capital of Czechoslovakia, with public buildings, mansions, and parks built by the reigning families of three centuries ago; with the working laboratories of many who laid the foundations of our modern science, literature, and history; a city whose citizens have for centuries and do yet believe that culture and knowledge are the only sure foundations for political peace and personal happiness. One must personally see Prague to get a realization of



State porcelain works—Meissen.

Porcelain works—F. Thomas—Marktredwitz.

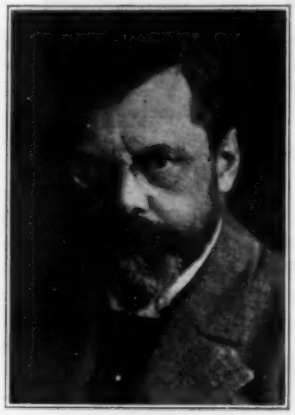
German Clay and Stoneware Works, General Ceramic Co., Munsterberg.

the intensity of the romance and chivalry of which mankind has been capable for the last few centuries.

Dresden: well-known by fame but not realizable except through personal experience; dignified in culture; playful to the extreme in recreation; inspiring industrially; the home of hospitable and broad-minded ceramists; a city worthy of a long sojourn. And one cannot go far in Berlin without realizing a very definite impression that history, culture, and joviality there prevails.

Otto Kauffman, Owner Mosaic Tile Works, Niedersedlitz.

Amsterdam: what pictures the name of this city brings to mind and yet how far short such pictures are. Here live men and women of our own blood, relatives of ours, with our ambitions and talents; and accomplishing things greatly worth while under conditions far more irksome than prevail generally in America. Thoroughly modern in family and personal matters, at peace politically, fully appreciative of the importance of culture and research, the Dutch people are modern in their industrial practices and have a great deal to show and to relate that will profit any American ceramists who will accept the invitations which they have so generously extended to members of the **Ceramists' Tour.**



Wolf Pfeiffer, General Manager, New Stadt Porcelain Manufacture, Meissen.

England: London, Birmingham, Stoke, Sheffield, Leeds, and Cornwall; such names as these suggest possibilities to the touring ceramists that are too many to relate here. And the personal welcome? A banquet in London, in Cornwall, in Stoke, and in Sheffield; plants of all sorts open, schools and institutes operating. The American ceramists will come away from England with a feeling that more welcome and more opportunities have been made available than any human could possibly respond to.

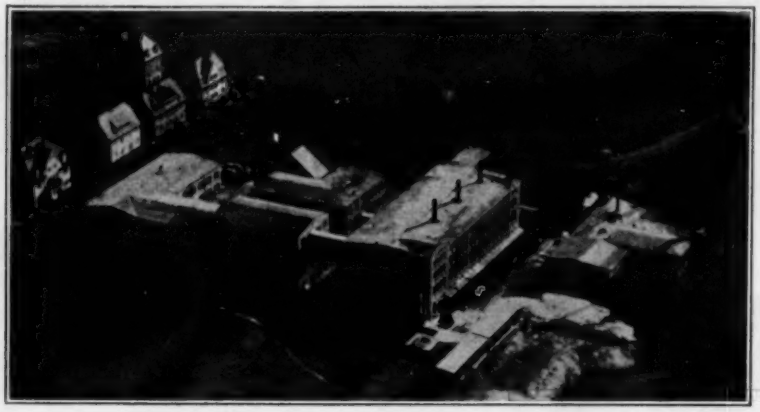
H. Harkort, Director of Stoneware Works, Velten-Vordamm.

Need one be reminded of the great many interesting British people, places, and buildings which are famous the world around? National educational, religious, and industrial history that has influenced American affairs very intimately will perforce be reviewed on this tour.

The hospitality and good fellowship of the British people are not surpassed.

As an opportunity worth many times its cost in dollars and time, this trip has appealed to a large number of American ceramists. Under no individually planned trip abroad can one meet so many of the European

ceramic leaders and have open such a variety of plants. If you are interested get your buddy to go along. Take your wife and family for whom special things of interest and benefit have been planned.



Porcelain works—John Haviland—Waldershof.

Certainly American ceramists will not willingly disappoint their ceramic fellows abroad who have planned so extensively to entertain. A fair measure of the expectations and desires to do for the members of this **Ceramic Tour** is found in the extensiveness and in the thoroughness of the itineraries they offer and in the many receptions

Derbyshire Silica Fire Brick Co. Near Buxton England.

and meetings which they have arranged. It is safe to assume that our European ceramic fellows will do for their American guests many times what can be read into or out of the meager words in the itinerary outlines.

For detailed information inquire of Ceramic Tour, Suite 656, 25 Broadway, New York City.

Comité Central des Maîtres de
Verreries de France,
Paris, February 22, 1928.

Ross C. Purdy,
General Secretary, American Ceramic Society, Inc.,
2525 N. High St.
Columbus, Ohio.

Mr. General Secretary:

Regarding the project of the trip to France by a delegation of ceramists from America, we have the honor to inform you that our Central Committee is glad to consider, in addition to the banquet in concord with the Syndicat des Fabricants de Produits Ceramiques de France, visits to some plants among the most characteristic of our industry, that is:

(1) Visit to the Glaceries of Saint Gobain at Tourotte, near Compeigne.
(2) Visit to the Lalique Establishment at Paris.
(3) Visit to the Cristalleries, or to Baccarat, or to Saint Louis, in the East of France.

Note that the latter visit, to plants situated nearly 400 kilometers from Paris, will require careful organization of time tables and means of transportation on your part.

We are agreeable to leaving to you the arranging of the dates and details of these different excursions, all of them resting certainly at your entire disposal for more ample information.

Please accept, Mr. General Secretary, the expression of our sincere regards,

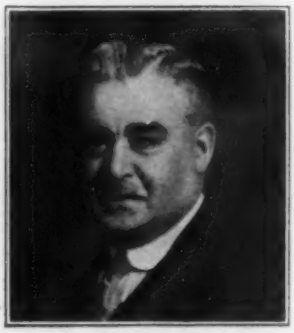
The General Delegate.

British Reception Committee

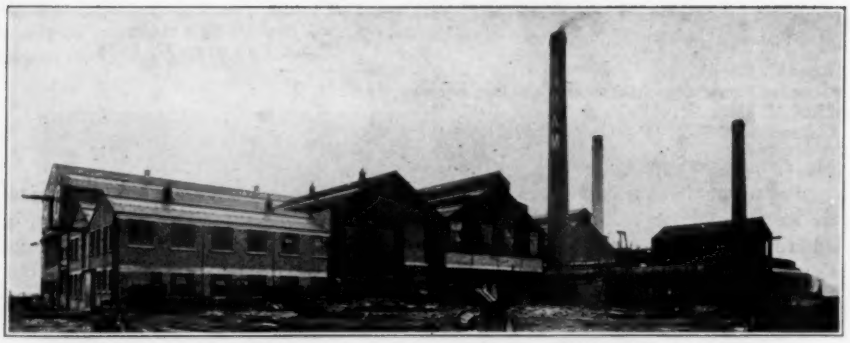
Chairman: H. J. C. Johnston, President, Ceramic Society, Past-President Institute of Clayworkers; President, Clay Convention, 1927.

Vice-Chairman: W. Butterworth, M.A., President, Society of Glass Technology.

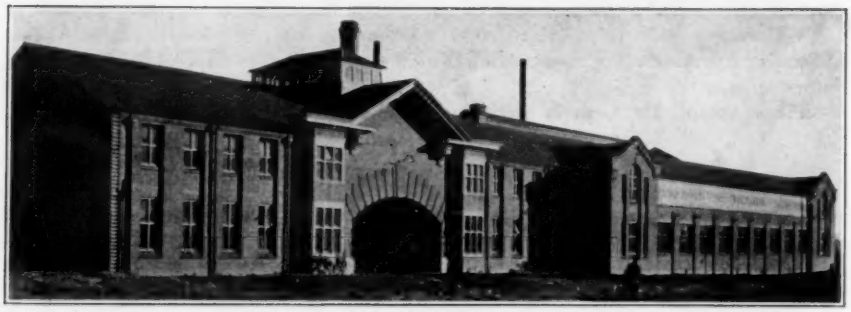
W. H. Allen, Chairman, National Pipe Committee.
G. Allman, Member of Council Ceramic Society.
G. Andrews, Smeed, Dean & Co., Ltd., Sittingbourne.
H. V. Argyle, Chairman, Midland Pipe Association.
A. J. Arnold, Past-President, Refractories Association of Great Britain.
J. A. Audley, Member of Council, Ceramic Society.
J. C. Bailey, J.P., Vice-President, British Pottery Manufacturer's Association.
W. A. Bailey, Rockware Glass Syndicate, Ltd.
A. Barrett, Chairman, Enameled Sanitary Manufacturer's Association.
D. F. Bishop, Member of Council, Ceramic Society.
F. J. Boam, Past-President, Refractories Association of Great Britain.
Horace Boot, Eastwoods, Ltd., London.
F. H. Brooke, Vice-President, Ceramic Society.
G. E. Bullock, J.P., Chairman, British Pottery Manue facturer's Association, Sanitary Earthenwar-Manufacturers' Association, etc.
J. Burton, Past-President of Ceramic Society.
A. J. Campbell, Member of Council, Pottery Section Ceramic Society.
G. Campbell, Chairman of Council, Ceramic Society.
F. E. Clark, Chairman, Enamel Association.
J. Connolly, Treasurer, Society of Glass Technology.
Sir John Courtis, Past-President, Institute of Clayworkers.
S. H Dodd, Secretary, British Pottery Manufacturers' Federation; Vice Chairman and Secretary, Porcelain Electrical Fittings Association; Chairman and Secretary, Fine China and Earthenware Manufacturers' Association.



Christopher Wilson, Managing Director, Osram Lamp Works.



Glass works—General Electric Co., Osram, Berlin.

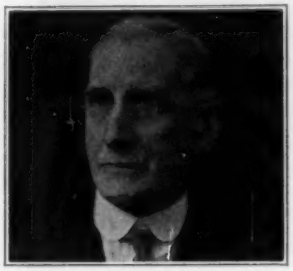


James Powell & Sons Glass Works.

Glass pot oven—James Powell & Sons.

J. Dunnachie, Glenboig Union Fireclay Company, Ltd.
E. Lloyd Edwards, Chairman, Terra Cotta Association.
W. H. Facon, Secretary, Midland Pipe Association, etc.
P. Ferguson, Past-President, National Building & Engineering Brick Federation.
W. Fullwood, Secretary, Stourbridge Fire Brick Trade.
W. S. Goodison, Treasurer, Refractories Association of Great Britain.
H. R. Graves, Secretary, Northern Building & Engineering Brick Federation.
H. E. Hailwood, Hailwood & Ackroyd, Ltd.
H. Halliday, Chairman, Employers' National Council for the Clay Industries.
Colonel S. C. Halse, C.M.G., Past-President, Society of Glass Technology.
A. Heath, Member of Council, Ceramic Society.
Sir Sydney Henn, M.P., Chairman, Glass Manufacturers' Federation.
J. P. Holcroft, Past-President of Ceramic Society.
J. Holland, President, Refractories Association of Great Britain.

A. Marriott Powell, Director, James Powell & Sons Glass Works.

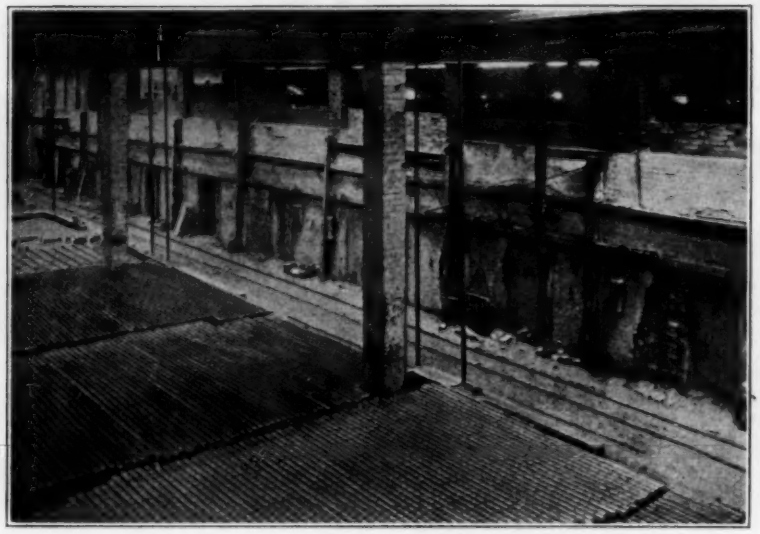


W. Butler, Glass Works Manager.

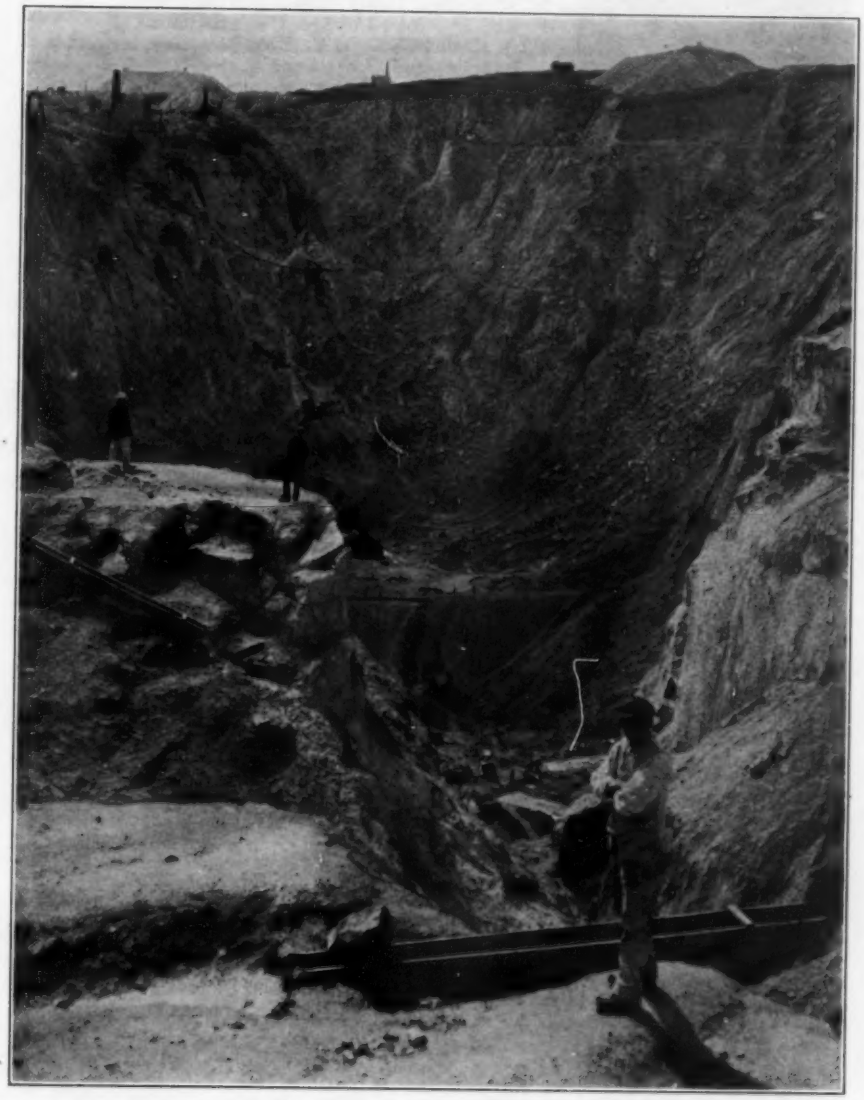
L. J. E. Hooper, Doulton & Company, Ltd.
J. Hoyle, Associated China Clays, Ltd., St. Austell.
E. J. Johnson, Chairman, General Earthenware Manufacturers' Association; Vice Chairman, British Pottery Manufacturers' Association.
Colonel Harry Johnson, D.S.O., T.D., Past Vice-Chairman, British Pottery Manufacturers' Association.
H. J. Johnson, J.P., President, British Pottery Manufacturers' Association.
R. L. Johnson, Past Vice-Chairman, British Pottery Manufacturers' Association.
A. B. Jones, Jr., Past Chairman, National Council of the Potteries Industry; Deputy Chairman, English China Manufacturers' Association.
H. L. Jones, Past Vice-Chairman, British Pottery Manufacturers' Association.
Sir W. J. Jones, K.B.E., Past President, Ceramic Society.
Lieut. Colonel W. J. Kent, J.P., Chairman, National Council of the Pottery Industry.
H. J. Lawrence, President, National Building & Engineering Brick Federation.
A. Leese, Past President of Ceramic Society.
J. S. Lovering, Associated China Clays, Ltd., St. Austell.
W. S. Malcom, Chairman, National Association of Roofing Tile Manufacturers.
S. R. Maw, Chairman, Glazed and Floor Tile Manufacturers' Association.
S. McPherson, Secretary, National Association of Clayworks Managers.
Dr. J. W. Mellor, F.R.S., Hon. Secretary, Ceramic Society.
A. H. Middleton, Consett Iron Company, Ltd.
H. Greville Montgomery, J. P., Hon. A.R.I.B.A., Hon. Secretary, Institute of Clayworkers.
Bernard Moore, Past-President, Ceramic Society.
B. J. Moore, Member of Council, Ceramic Society.
T. C. Moorshead, Past-President, Society of Glass Technology.
W. T. Munro, The British Thomson-Houston Co., Ltd.
Master of the Glass Sellers Company.
Master of the Glaziers Company.
F. Parkyn, Associated China Clays, Ltd., St. Austell.

F. G. Orme, Secy., Messrs. James Powell & Sons, Glass Works.

Glass cutting—James Powell & Sons.



Continuous kilns, the Derbyshire Silica Fire Brick Co.



China clay quarries of Bugle—Cornwall.

W. G. P. Hutchenson, Art Director, Messrs. James Powell & Sons Glass Works.

C. C. Paterson, O.B.E., Director of Research Laboratories, General Electric Company, Ltd.
A. M. Powell, James Powell & Sons, Harrow.
F. Redfern, John Lumb & Co., Castleford.
W. J. Rees, B. Sc., F.I.C., Hon. Secretary, Refractories Association of Great Britain.
A. Rigby, Asst. Secretary of Ceramic Society.
A. G. Richardson, Past-President of Ceramic Society.
J. Rogers, J.P., Associated China Clays, Ltd., St. Austell.
F. Russell, President, National Association of Clayworks Managers; Past-President, Refractories Association of Great Britain.
Walter Sessions, Associated China Clays, Ltd., St. Austell.
A. G. Shaw, Past Chairman, Enamel Association.
A. J. Sherwin, Vice-Chairman, Glazed and Floor Tile Manufacturers' Association.
T. Simpson, Member of Council, Ceramic Society.
T. A. Simpson, Member of Council Ceramic Society.
T. G. Simpson, Member of Council, Ceramic Society.
Charles Sitch, M.P., Stourbridge.
Colonel Alan Stein, M.C., John C. Stein & Co., Ltd.
Sir Alfred Stephens, Kidwelly.
A. H. Stephenson, J.P., Chairman, Birmingham Brick Association.
P. Malcom Stewart, J.P., O.B.E., Past-President, Institute of Clayworkers.
E. Taylor, Secretary, Midland Brick Association.
Colonel C. W. Thomas, Chairman, British Refractories Research Association.
F. Turner, Past-President of Ceramic Society.
Professor W. E. S. Turner, D.Sc., M.Sc., Secretary, Society of Glass Technology.
E. Gwynne Vevers, President, Institute of Clayworkers.
H. Webb, Chairman, British Flint Glass Manufacturers' Association.
J. T. Webster, J.P., Past Vice-Chairman, British Pottery Manufacturers' Association.
Major F. H. Wedgwood, J.P., Past Chairman, National Council of the Pottery Industry.
Frank West, Past-President, Ceramic Society.
Alfred Williamson, President, Northern Building & Engineering Brick Federation.
G. Wink Wight, C.A., Secretary, National Building and Engineering Brick Federation, and Refractories Research Association.
C. Wilson, General Electric Company, Ltd.
H. E. Wood, Past-President of Ceramic Society.
W. F. J. Wood, C.B.E., B.Sc., President, Glass Research Delegacy.
F. S. Worthington, Treasurer of Ceramic Society.
H. Wragg, M.P., Past President, Institute of Clayworkers.
W. H. Wright, Past President, National Building and Engineering Brick Federation.

NEW MEMBERS RECEIVED FROM FEBRUARY 1 TO MARCH 1

CORPORATION

The Sand-Lime Brick Assn., Saginaw, W. S., Michigan, John L. Jackson, Pres.

PERSONAL

Joseph R. Buchanan, Asst. to Vice President, Mayer China Co., 701 Irvine Sq., Beaver, Pa.

John B. Cahoon, Salt Lake City, Utah.

Edward J. Conlan, Secy. and General Mgr., Greiner Glass Mfg. Co., Inc., Brooklyn, N. Y.

Francis J. Curtis, Technical Advisor, Merrimac Chemical Co., 148 State St., Boston, Mass.

James J. Dodd, Wunderlich Ltd., Rosehill Tileries, Parramatta, N.S.W., Australia.

Fritz Eckert, Zehlendorferstr. 18, Berlin-Lichterfelde, Germany. Instructor for Glass Technology Charlottenburg.

Virginia B. Evans, Artist, Fostoria Glass Co., Moundsville, W. Va.
John S. Grasty, Consulting Geological Engineer, Charlottesville, Va.
Samuel S. Groglode, Sales Engineer, DeGraw-Stowe & Co., East Liverpool, Ohio.
Harold Grossman, 22 Farrington St., Caldwell, N.J., Chemist, American Lead Pencil Co.
Walter G. Hamlin, Assistant Chemist, 9415 Miles Ave., Cleveland, Ohio.
Sterling C. Hoshour, Superintendent, Colonial Brick Corp., Winchester, Va.
John Koracs, 21 Russell St., Vauxhall, N. J., President, Vauxhall Art Pottery Works, Inc.
Harlan S. Miner, 915 Monmouth St., Glouster City, N.J., Chief Chemist, Welsbach Co.
Harold G. Musselman, 355 Maryland Ave., Westport, Baltimore, Md.,
Clara K. Nelson, Professor of Design, N. Y. School of Clayworking and Ceramics, Alfred, N. Y.
Paul M. Offill, Sales Engineer, 17 Wilmont Ave., Washington, Pa.
Selick I. Perkal, Chemical Engineer, Industry of the Supreme Council of Public Economy, Kharkoff, Ukraine.
Mrs. Walter Steele, Boulder, Colo.
Charles Stegmayer, Ceramic Engineer, Mutton Hollow Fire Brick Co., Sewaren, N. J.
Samuel R. Stephenson, c/o Supt. Plant, Stephenson Brick Co., Decatur, Ala.
Lyman R. Squier, Ceramist, N. J. Terra Cotta Co., Perth Amboy, N. J.
J. Cecil Teft, Superintendent Trenton Potteries, Trenton, N. J.
Gertrude Rupel Wall, 1285 Hearst Ave., Mgr. and Designer, Walrich Pottery, Berkeley, Calif.
G. W. Wortley, c/o R. & A. Main, Ltd., Falkirk, Scotland.

STUDENT

Paul F. Collins, Ohio State University, Columbus, Ohio
William S. Emley, 3rd, Rutgers Univ., New Brunswick, N. J.
Wm. H. Holl, Penn. State College, State College, Pa.
Houston C. Joyner, Univ. of Illinois, Urbana, Ill.
John R. Kauffman, Rutgers Univ., New Brunswick, N. J.
William C. Kempf, Rutgers Univ., New Brunswick, N. J.
Reuel Lipman, Penn. State College, State College, Pa.
Edward P. Lohmann, Iowa State College, Ames, Iowa.
J. P. Mulroy, N. Y. State School of Clayworking & Ceramics, Alfred, N. Y.
Frederick R. Neel, Ohio State Univ., Columbus, Ohio.
L. Russell Shardlow, N. Y. School of Clayworking & Ceramics, Alfred, N. Y.
Harold A. Stouck, Penn. State College, State College, Pa.
Raymond B. Whitter, N. Y. School of Clayworking and Ceramics, Alfred, N. Y.

Membership Workers' Record

	CORPORATION		PERSONAL
W. H. Crume	1	J. A. Ryan	1
	PERSONAL	G. T. Stowe	1
A. I. Andrews	1	E. W. Washburn	1
Fred B. Bentley	1	Office	5
P. P. Budnikoff	1		—
M. W. Butler	1	Total	25
C. P. Cahoon	1		STUDENT
W. F. Dalzell	1	G. H. Brown	1
Marion L. Fosdick	2	Paul E. Cox	1
James Gillinder	1	C. W. Parmelee	1
B. D. Hardesty	1	J. B. Shaw	3
C. A. Hoshour	1	L. R. Squier	2
A. H. Johnson	1	A. S. Watts	2
S. C. Lyons	1	F. Westendick	3
O. E. Mathiasen	1		—
T. Poole Maynard	1	Total	13
C. B. McComas	1	Grand Total	39
R. G. Mills	1		

PERSONAL NEWS FROM MEMBERS OF THE SOCIETY

Vance Cartright, formerly a student at the Univ. of Wash., Seattle, is located at 248 Darragh St., Pittsburgh, Pa.

James R. Crandall is now doing research work at the D. E. McNichol Pottery of W. Va., Clarksburg, W. Va.

John S. Grainer is now at the Grand Rapids Vitreous Products Co., Belding, Mich. He was formerly associated with the Vitreous Enameling Co., Cleveland, Ohio.

J. R. Grout, Jr. has accepted a position with the Ludowici-Celadon Co., Coffeyville, Kans., Mr. Grout formerly was located at Danville, Illinois, Acme Brick Co.

James O. Handy, Director of Metallurgical Investigations, Pittsburgh Testing Laboratory, has removed his laboratory to New York City, 72 Washington St.

Robert E. Kohler, American Encaustic Tiling Co., has been transferred from the Zanesville plant to the New York Office at 16 East 41st St.

L. H. Menne, formerly with the Peoples Gas Stores, Chicago, Ill., is now located Quincy, Ill. with the Quincy Vitreous Enamel Co.

R. G. Mills, formerly of Rutgers University, Department of Ceramics, is now a member of the staff in the Department of Ceramic Engineering, University of Illinois, Urbana, Ill.

R. H. Minton who has been associated with the General Ceramics Co., has resigned from his position as general superintendent. Mr. Minton's plans have not been announced except for a limited amount of consulting work.

Hans Navratiel of Beuthen, Germany, is located at 304 W. 3rd St., Flint, Mich.

W. G. Owen, recently sales manager for the Haws Refractories Co., Johnstown, Pa. is now associated with the General Refractories Co., Sixteenth St., Philadelphia, Pa.

Wilbur H. Pfeiffer, who has been employed with The Carborundum Company Niagara Falls, N. Y. has moved to 25 E. First St., Dayton, Ohio.

Harold L. Pope, has changed his address from Leonard Refrigerator Co., Grand Rapids, Mich., to the Electric Refrigeration Corp., 14250 Plymouth Rd., Detroit, Mich.

T. A. Shegog is now located at Topliff Hotel, Spruce Pine, N. Car.

The Surface Combustion Company has removed from New York City to 2375 Dorr St., Toledo, Ohio.

John D. Whitmer, formerly associated with the American Encaustic Tiling Co., Zanesville, Ohio, is now with the Flint Faience Tile Co., Flint, Mich.

CONSTITUTION AND BY-LAWS OF THE AMERICAN CERAMIC SOCIETY

[As it would be if amended as proposed by the Committee on Rules. See *Bull. Amer. Ceram. Soc.*, 7 [3] 59 (1928).]

Constitution

Article I

(1) This SOCIETY shall be known as THE AMERICAN CERAMIC SOCIETY.

(2) The object of the SOCIETY is to advance the ceramic arts and sciences by meetings for the reading and discussion of papers, the publication of scientific literature, and other activities.

Article II

Membership

(1) The SOCIETY shall consist of Honorary, Ex officio Honorary, Active, Life Active, Associate, Corporation, Industrial Association, and Life Corporation Members.

(2) Honorary Members must be persons of professional eminence, elected in recognition of their achievements in ceramic art or science. Their number shall not exceed ten.

(3) An Honorary Member shall be nominated by at least ten Active Members and unanimously approved by the Board of Trustees. Their nomination shall be placed before the SOCIETY at an annual meeting, and to be elected they must receive the affirmative vote of at least 90% of those voting, by letter ballot, at the next succeeding annual election.

(4) Ex officio Honorary Members must be such officers of such other associations and societies as shall be unanimously designated by the Board of Trustees, the name of the person holding such office appearing on the SOCIETY roster as Ex officio Honorary Member during the term of his incumbency only.

(5) Active Members must be persons competent to fill responsible positions in ceramics. Only Associate Members shall be eligible to election as Active Members and such election shall occur automatically twenty-four months after acceptance as an Associate Member.

(6) Life Active Members must be those members, Active or Associate, who make single payment of an endowment fee as prescribed in Article III. Life Active Members shall have the same rights as Active Members.

(7) Associate Members must be persons interested in the ceramic or allied industries.

(8) Corporation Members must be persons, firms, or corporations who, being interested in the SOCIETY, make such financial contributions for its support as are prescribed in Article III. Their membership shall become operative on payment of dues as prescribed in Article III.

(9) Life Corporation Members must be persons, firms, or corporations who make single payment of an endowment fee as prescribed in Article III. Life Corporation Members shall have the same rights as Corporation Members.

(10) Industrial Association Members must be organized groups of manufacturers, who being interested in the advancement of ceramic arts and sciences shall make, for this purpose, such financial contributions as are prescribed in Article III.

(11) All Honorary Members, Ex officio Honorary Members, Active Members, Perpetual Active Members, Associate Members, Corporation Members, Perpetual Corporation Members, and Industrial Association Members shall be equally entitled to the privileges of membership, except that only Active, Perpetual Active, one representative of each Corporation Member and one representative of each Perpetual Corporation Member shall be entitled to vote. Such representative shall be officially designated by the person, firm or corporation represented. Only Active and Perpetual Active Members shall be entitled to hold office. The roster of each grade of membership shall be printed separately in at least one publication issued by the SOCIETY annually.

(12) Any person may be expelled from any grade of the Membership of the SOCIETY if charges signed by five or more Active or Perpetual Active Members be filed against him or her, and if the Board of Trustees examine into and sustain said charges by a majority vote. Such person, however, shall be notified of the charges against him and be given a reasonable time to appear before the Board of Trustees or to present a written defense before final action is taken. In case of such expulsion, any moneys paid the SOCIETY as endowment fees become forfeit to the SOCIETY and automatically become part of the research fund.

Article III

Dues

(1) Honorary and Ex officio Honorary Members shall be exempt from all fees and dues.

(2) The annual dues for Active and Associate Members shall be fixed by the Board of Trustees but shall not exceed ten dollars, six of which shall be a subscription to the *Journal of the American Ceramic Society*.

(3) Life Active Members shall pay a single endowment fee of $200.00, the interest earnings from which shall be used during the life of the member for current expenses. Upon the death of the member, the interest shall be used according to the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

(4) Corporation Members shall pay such annual dues as are fixed by the Board of Trustees but these shall not be less than twenty-five dollars, six dollars of which shall be a subscription to the *Journal of the American Ceramic Society*. The privileges of membership shall begin upon payment of the annual dues.

(5) Life Corporation Members shall pay a single endowment fee of $600.00, the interest earnings from which shall be used for current expenses for a period of twenty-five years after which time the interest shall be used according to the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

(6) Industrial Association Members shall pay such annual dues in monthly installments or single payment as shall be agreed upon by the Association and the Board of Trustees, but such dues shall not be less than $480.00 annually.

Article IV

Officers

(1) The affairs of the SOCIETY shall be managed by a Board of Trustees, consisting of the President, Vice President, Treasurer, the two most recent past Presidents, and one trustee representative of each of the Divisions. The President, Vice President, and Treasurer shall be elected to serve one year. Each trustee shall be elected to serve three years.

(2) The President shall have general supervision of the affairs of the SOCIETY under the direction of the Board of Trustees and shall perform such other duties as pertain to his office.

(3) He shall countersign the checks drawn by the Treasurer when such drafts are known by him to be proper and duly authorized by the Board of Trustees.

(4) A secretary shall be appointed by the Board of Trustees for a term of not more than two years.

(5) The Secretary shall see that all moneys due the SOCIETY are carefully collected and transferred to the custody of the Treasurer. He shall carefully scrutinize all expenditures and use his best endeavors to secure economy in the administration of the SOCIETY. He shall personally investigate and certify the accuracy of all bills or vouchers on which money is to be paid. He shall have charge of the books of accounts of the SOCIETY and shall furnish monthly to the Board of Trustees a statement of monthly balances. He shall present annually to the Board of Trustees a balance sheet of his books as of the 31st of December and shall furnish from time to time such other statements as may be required of him.

(6) He shall conduct the correspondence of the SOCIETY and keep full record of the same. He shall transmit promptly to the Board of Trustees for their consideration all communications not of routine nature. He shall cause to be published in the *Journal* the results of all balloting on the business of the SOCIETY unless otherwise ordered by the Board of Trustees. He shall perform all other duties which may from time to time be assigned to him by the Board of Trustees.

(7) The Secretary may be paid a salary to be determined by the Board of Trustees.

(8) The Secretary shall furnish a suitable bond for the satisfactory performance of his duties, which shall be held in the custody of the President.

(9) The Treasurer shall receive all moneys due the SOCIETY and deposit the same

in the name of the SOCIETY in a national bank designated by the Treasurer and approved by the Board of Trustees. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Trustees. He shall pay all bills by draft, when certified by the Secretary or as ordered by the Board of Trustees. He shall furnish a satisfactory bond for the proper performance of his duties, which shall be held in the custody of the President.

(10) All securities belonging to the SOCIETY shall be held in the custody of the Treasurer.

(11) The accounts of the Secretary and of the Treasurer shall be audited before each Annual Meeting by a certified public accountant or some other competent person designated by the Board of Trustees.

(12) A vacancy in any office shall be filled by appointment by the Board of Trustees but the new incumbent shall not thereby be rendered ineligible for reëlection to the same office at the next Annual Meeting. On the failure of any officer or any member of a committee to execute his duties within a reasonable time, the Board of Trustees, after duly warning such person, may declare the office vacant and appoint a new incumbent.

(13) A majority of the Board of Trustees shall constitute a quorum, but the Board of Trustees shall be permitted to carry on such business as they may desire by letter.

Article V

Nominations and Elections

(1) There shall be two nominating committees selected at each Annual Meeting. Such committees will each consist of seven members, one from each Division of the SOCIETY and each will prepare an independent ticket of nominations to be submitted to the SOCIETY for ballot. The Secretary of the SOCIETY shall be Chairman (without vote). The members of the Nominating Committees will be selected as follows: At the final session of each Division two members of that Division will be elected to the Nominating Committee. These two will draw to determine which shall be on Committee No. 1 and which on Committee No. 2. The names and designations of these elected members of each Division will be immediately reported to the Secretary by the chairman or acting chairman of each Division.

Each nominating committee will be notified of its membership by the Secretary and each Committee will at once appoint its own Chairman and proceed to the nomination of officers for the ensuing year.

There are no restrictions as to the makeup of the two tickets and the same or different names may appear upon the two slates.

(2) Nominations for President, Vice President, and Treasurer. The Nominating Committees shall, by majority letter vote, select nominees for President, Vice President, and Treasurer.

(3) Nominations for Trustees. Each Division by plurality letter vote of its members shall elect a Trustee to serve for a period of three years, according to the schedule provided in Section X of the By-Laws. The names of the Trustees thus chosen by the Divisions shall be certified to the Secretary of the SOCIETY not later than December 31 of each year.

The names of the nominees for Trustees thus chosen by the Divisions shall be transmitted to the Secretary of the SOCIETY (as ex-officio Chairman of the Nominating Committee) not later than September first, and by him shall at once be transmitted to the members of the Nominating Committee, and shall be placed on the election ballot.

At least ninety days before the Annual Meeting the Secretary shall send the names of all nominees to each voting member of the SOCIETY.

(4) Election. The names of all nominees, provided their assent has been obtained before nomination, shall be placed upon a printed ballot in alphabetical order and shall be mailed to each voting member not in arrears at least twenty days before the Annual Meeting. The voting shall be confined to the names appearing on this ballot. The ballot shall be inclosed in an envelope on which there shall be no mark of identification other than the word "Ballot." The envelope shall be enclosed in another envelope for mailing, addressed to the Secretary, upon the back of which the voter shall endorse his name.

The envelopes and ballots shall be opened in the presence of three scrutineers appointed by the President, who will report the result of the election at the Annual Meeting.

A plurality of affirmative votes cast shall elect.

Article VI

Standing Committees

(1) Except as otherwise provided the following Standing Committees shall be appointed annually by the Board of Trustees:

1. Rules
2. Publications
3. Membership
4. Standards
5. Sections and Divisions
6. Papers and Programs
7. Research
8. Geological Survey
9. Data
10. Ceramic Education
11. A Coördinating Service Council

Except as otherwise provided the chairman of each committee shall be appointed by the Board of Trustees.

(2) The Committee on Rules shall consist of the Chairmen of the Rules Committees of the Divisions having such committees. It shall receive all recommendations relating to changes of Constitution and By-Laws and shall report upon the same to the Secretary for transmission to the SOCIETY. It shall have power to propose changes in the Rules of the SOCIETY.

(3) The Committee on Publications shall consist of the Editor and four members. The duties of the Editor and Committee on Publications are defined under Article X on Publications.

(4) The Committee on Membership shall consist of the Chairmen of Membership Committees of the Divisions having such committees, and shall have power to appoint subcommittees. Its function shall be to undertake systematically the enlargement of the membership of the SOCIETY among those interested in the ceramic and allied industries.

(5) The Committee on Standards shall consist of a chairman appointed by the Board of Trustees and topic groups as follows:

(A) Group on Definitions, consisting of three members appointed by the Board of Trustees.

(B) Group on Raw Material Specifications, consisting of three members appointed by the Board of Trustees.

(C) Group on Standardization of Tests, consisting of one member selected by each Division.

(D) Group on Standardization of Products, consisting of one member selected by each Division.

(6) The Divisional Standardization Committees shall be selected by their respective Divisions. Their function shall be the preparation of tests and specifications for the materials and products of their respective branches of the ceramic industry. Each shall be responsible to its Division, but all reports, resolutions or recommendations that are to be printed or generally distributed shall be approved by the Committee on Standards before publication.

(7) The function of the Committee on Standards shall be to prepare or have prepared tests and specifications for ceramic materials and products and to submit to the Board of Trustees written reports, resolutions, and recommendations relating thereto. The Committee may report at any regular meeting of the SOCIETY. For adoption, these reports, resolutions, and recommendations must be submitted in printed form to the members of the SOCIETY at least six months before a vote may be taken, during which time any amendments, changes, or corrections, suggested by any member may, with the approval of the Committee, be incorporated. The reports, resolutions, and recommendations as amended shall then be submitted by letter ballot to the voting members. A two-thirds vote shall be required for adoption, and the polls shall close sixty days after distribution of the ballot.

(8) The Committee on Sections and Divisions shall consist of five members in addition to the chairmen of the Divisions. Its duties shall be to promote the organization and welfare of Local Sections, Student Branches, and Divisions.

(9) The Committee on Papers and Programs shall consist of the Secretaries of the Divisions, the Secretary of the SOCIETY, and such other persons as the Board of Trustees may deem advisable. Its duties shall be to procure papers and discussions for the meetings and publications of the SOCIETY. The Committee may require an abstract of any paper submitted before placing it upon a program.

(10) The Committee on Research shall consist of one member selected by each Division. Its duties shall be to organize and encourage scientific investigations pertaining to the ceramic and related industries, especially those investigations which will stimulate the development of our national industries and resources. It shall be empowered to coöperate with similar committees of other scientific societies and with Government bureaus.

(11) The Committee on Geological Surveys will coöperate with national and state geological surveys and associations in planning laboratory and plant investigations instituted by them, and interpreting data. This Committee shall consist of a chairman and four members appointed by the Board.

(12) The Committee on Data shall arrange symposiums and prepare for publication monographs, bibliographies, statistics, etc. This Committee shall consist of one member selected by each Division.

(13) The Committee on Ceramic Education shall consist of one representative selected by each Division. This Committee shall make recommendations through the Board of Trustees for the betterment of ceramic education in institutions now established and for the encouragement of new departments of ceramics where the demand and facilities warrant.

(14) The Coördinating Service Council shall consist of the General Secretary, Ex-officio Chairman, and the Chairmen of the Committees on Research, Standards, Geological Surveys, Data, and Ceramic Education. The Council shall have general supervision of the work of these Committees, for the purpose of coördinating other organizations on ceramic topics and problems.

Article VII

Divisions

(1) Groups to be known as Divisions of the SOCIETY and to be organized from

members of the SOCIETY may be authorized by the Board of Trustees for stimulating the growth and development of the SOCIETY, when such action shall seem wise and expedient. Only bona fide members of the SOCIETY are entitled to affiliate with and participate in the activities of such Divisions, but Divisions which, prior to August, 1920, have enrolled persons who are not members of the SOCIETY, may retain such persons as members of the Division. A member of the SOCIETY may enroll in any Division in which he is interested but for the purpose of nominating for Division representative on the Board of Trustees each member must declare one and only one Division as his major Division, and he shall be designated as a major member of that Division.

(2) The affairs of a Division shall be managed by a Chairman, a Secretary-Treasurer, and such other officers as the Division may deem necessary. The officers of the Division shall be elected annually by ballot at the last session of the Division held during the Annual Meeting of the SOCIETY and shall take office at the close of the meeting at which they are elected. All members of a Division are entitled to vote. The officers shall hold office for one year or until their successors are elected.

(3) Representatives of Divisions upon Committees of the SOCIETY shall be as indicated in Article VI.

(4) Divisions shall have power to make their own rules and by-laws except that they shall not adopt any rule or by-law which conflicts with the Constitution and By-laws of the SOCIETY as a whole.

Article VIII

Local Sections

(1) Local Sections, each carrying some distinguishing title prefixed to the words "Section of the AMERICAN CERAMIC SOCIETY," may be authorized by the SOCIETY.

(2) The purposes of such Sections shall be to strengthen and extend the work of the SOCIETY, as defined in Article I of the Constitution, by more frequent meetings in local centers than are possible to the SOCIETY as a whole, and by bringing the benefits of the work to persons who would not otherwise be reached.

(3) Application for permission to form a Local Section must be in writing and signed by not less than ten members of the SOCIETY in good standing, residing in the general locality where the Section is to be formed, of whom one at least shall be an Active Member. To be considered at any given meeting an application must be filed with the Secretary at least thirty days prior to the date of the Meeting and notice that the application is pending must appear in the program of the Meeting. To be granted, the application must receive the affirmative vote of two-thirds of those present. In event of affirmative action the SOCIETY will issue a charter to the applicants, authorizing them to form a Section under the name proposed. Charters for Local Sections may be temporarily suspended by the Board of Trustees for cause, but no charter can be permanently rescinded except by vote of two-thirds of those present at a regular Meeting of the SOCIETY, after due publication in the program of the Meeting that the matter is pending.

(4) Local Sections shall have power to make their own rules and by-laws except that they shall not pass any rule or by-law which is in conflict with the rules of the SOCIETY.

(5) The officers of Local Sections shall be a Chairman, a Secretary, a Councillor, and such others as the Sections may prescribe. The duties of the Chairman and Secretary shall be such as usually pertain to those offices. The Councillor shall be an Active Member of the SOCIETY. He shall be elected by the Local Section and it shall be his duty to advise the Section in all matters pertaining to its relations with the SOCIETY and to make an annual report to the SOCIETY regarding the work and status of the Section. The names of the Chairman, Secretary, and Councillor of each Section shall appear in the roster of the SOCIETY.

Article IX

Student Branches

(1) Student Branches, each carrying some distinguishing title prefixed to the words "Student Branch of the AMERICAN CERAMIC SOCIETY," may be established in institutions in which regular courses of instruction in ceramics are maintained.

(2) The purpose of such Student Branches shall be to strengthen and extend the work of the SOCIETY, as defined in Section I of the Rules, by enlisting the interest and support of students in ceramics while still in school and by stimulating the spirit of ceramic research among them.

(3) Application to form a Student Branch in any institution must be in writing, signed by not less than five regularly enrolled students in good standing and endorsed by two or more members of the SOCIETY. The application must be filed and acted upon as provided for Local Sections in Section IX, and may be suspended or revoked for cause in the same manner.

(4) Student Branches shall have power to make their own rules and by-laws, except that they shall not pass any rule or by-law in conflict with the rules of the SOCIETY.

(5) The officers of Student Branches shall be a Chairman, a Secretary, a Councillor, and such others as the Student Branch may prescribe. The Chairman and Secretary shall be elected by the Student Branch and their duties shall be such as usually pertain to those offices. The Councillor shall be an Active Member of the SOCIETY, appointed by the Board of Trustees to act in this capacity to the Student Branch. The duties of the Councillor shall be to advise the Student Branch in all matters pertaining to its relations to the SOCIETY and to make an annual report to the SOCIETY regarding the work and status of the Student Branch. The names of the Chairman, Secretary, and Councillor of each Student Branch shall appear in the roster of the SOCIETY.

Article X

Publications

(1) The Board of Trustees shall employ at suitable compensation an Editor of the *Journal of the American Ceramic Society* and an Advertising Manager, both of whom shall be nominated by the Committee on Publications to the Board of Trustees.

(2) The Committee on Publications shall have general supervision of the publications of the SOCIETY and of contracts and expenditures connected therewith, subject to the approval of the Board of Trustees.

(3) In the consideration of papers offered for presentation or publication those papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purpose of the SOCIETY shall be rejected. The Committee on Publications shall determine which papers shall be printed. The Committee may return a paper to the writer for correction and amendation and may call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it.

(4) All papers, discussions, and other writings which may be of interest or value to the SOCIETY if published, and which have been presented before the SOCIETY, its Divisions, or Sections, and all committee reports shall become the property of the SOCIETY and their publication and other disposition shall be in the hands of the Committee on Publications.

Any papers, discussions, or writings not considered suitable for use in the publications of the SOCIETY by the Committee on Publications must be released or returned to the

authors for free use elsewhere and, upon request of authors, decision in this matter must be rendered in sixty days.

No committee reports prepared by a regularly appointed committee of the SOCIETY or of its Divisions or Sections shall be offered for publication elsewhere until the Committee on Publications shall have been given an opportunity of accepting such reports for publication by the SOCIETY.

(5) The Committee on Publications shall provide for the publication of a monthly periodical entitled the *Journal of the American Ceramic Society*, the subscription price of which shall be ten dollars to members and twelve dollars plus foreign postage to non-members.

(6) One copy of each issue of the paper bound edition of the *Journal* shall be sent prepaid to each member of the SOCIETY not in arrears. No member shall be furnished with more than one copy of each issue free for any single year. A member may be permitted to complete by purchase one file of the publications of the SOCIETY at less than the current commercial rate, the amount to be fixed by the Board of Trustees and to be called the member's rate.

(7) The Secretary shall have the custody of all publications of the SOCIETY, shall keep them safely stored and insured, and shall sell them to the public at prices which shall be fixed by the Board of Trustees. The Board of Trustees shall also, from time to time, fix the price of the volumes remaining unsold and shall have authority to refuse to sell the back volumes of the *Transactions* and *Journals* except in complete sets, at such time as the quantity remaining of any number becomes so small as in their judgment to warrant such action.

(8) The Editor shall request the author of each article appearing in the *Journal of the American Ceramic Society* to fill out and sign, within a definite time limit, a form, specifying the number of reprints of said article, if any, which he desires. This form shall contain a table from which can be computed the approximate cost at which any reprints will be furnished. In event that the expense of furnishing the desired number of reprints is large, the Board of Trustees may require the author to pay part or all of the cost involved before the publication of the reprints is begun. On receipt of such signed order within the time limit set the Editor shall cause to have printed the desired number of copies. If the author makes no reply or replies after the time limit has expired then the SOCIETY will not be responsible for the publication of any reprints of the article in question except at the usual market price for the printing of new matter.

(9) No one shall have the right to demand the publication of an article independent of the discussion which accompanied it and no one having taken part in a discussion upon an article shall be entitled to order reprints of the discussion separately and apart from the article itself.

(10) The SOCIETY is not, as a body, responsible for the statement of facts or opinions expressed by individuals in its publications.

Article XI

Parliamentary Standard

Roberts' "Rule of Order" shall be the parliamentary standard on all points not covered by these rules.

Article XII

Amendments and Changes

Any proposed amendment to or change in this Constitution must be presented in writing at the Annual Meeting of the SOCIETY and, if approved by the Committee on Rules or by any ten Active Members, must be printed on a ballot and sent out not earlier than thirty nor later than sixty days after the adjournment of the Meeting at which the amendment or change was presented. If the said letter ballot shows an

affirmative vote of not less than two-thirds of the total vote cast within thirty (30) days after the date of mailing, then the same shall be declared carried and shall at once become effective.

Article XIII

By-laws

The SOCIETY shall make such By-laws not in conflict with this Constitution as may be necessary for the proper government of the SOCIETY. Such By-laws shall become operative when approved by the Board of Trustees and confirmed by a two thirds affirmative vote of the members voting at any annual meeting.

Section I

Meetings

(1) The Annual Meeting shall take place on the first Monday in February, or as soon thereafter as can be arranged, at such place as the Board of Trustees may decide, at which time reports shall be made by the Board of Trustees, Treasurer, and scrutineers of election, and the accounts of the Treasurer shall be audited by a committee of three appointed by the President. Fifty Active Members shall constitute a quorum at the Annual Meeting and a majority shall rule unless otherwise specified.

(2) Other meetings may be held at such times and places during the year as the Board of Trustees may decide, but at least twenty days notice shall be given of any meeting.

(3) The President shall appoint at the Annual Meeting a committee of five, to be known as the Summer Meeting Committee, whose duty it shall be to arrange for a summer excursion meeting at some suitable point. They shall then select a local committee which shall have charge of the details of the meeting. The expenses of the Summer Meeting Committee in arranging the program of visits and for printing, rooms, and facilities for meetings shall be borne by the SOCIETY.

Section II

(1) At the Annual Meeting of the SOCIETY, the order of business shall be as follows:

1. President's Address
2. Reading of Minutes of Last Meeting
3. Committee Reports
4. Reports of the Board of Trustees and Treasurer
5. Old Business
6. New Business
7. Reading of Papers
8. Announcement of Election of Officers, Honorary and Active Members
9. Installation of Officers
10. Appointment of Committees
11. Adjournment

Section III

Only Active Members shall be eligible to election as officers.

Section IV

Any members in arrears for over one year may be suspended from membership by the Board of Trustees until such arrears are paid. Active Members in arrears are not eligible to vote. The annual dues are payable on January first.

Section V

The Secretary of each Division, Local Section, and Student Branch shall report to the Secretary of the SOCIETY the names of its officers and Standing Committee Chairmen

within three weeks of their election or appointment and shall also furnish the Secretary with a complete list of its membership on April 1 of each year.

Section VI

(1) Any person interested in the ceramic and allied industries is eligible to membership in a Local Section.

(2) Local sections shall have power to fix their own dues or assessments, such dues or assessments being in addition to and independent of the regular dues and assessments of the SOCIETY upon its members. No Section shall have authority to incur debt in the name of the SOCIETY or for which the SOCIETY may become liable.

Section VII

(1) Membership in a Student Branch shall be limited to the instructional force and regularly enrolled students of schools in which branches are located, subject to the rules of the school concerned governing outside activities of students.

(2) Student Branches shall have power to fix their own dues and assessments and, as such, shall pay no dues to the SOCIETY. No Student Branch shall have authority to incur debt in the name of the SOCIETY or for which the SOCIETY may become liable.

(3) Members of a Student Branch shall pay no dues to the SOCIETY but upon depositing a certificate of good standing from their Secretary, may purchase from the SOCIETY its publications at the same rate as Associate Members of the SOCIETY. This privilege shall cease when the student's connection with the school ceases, but members of a Student Branch, upon leaving school, may at once become Associate Members of the SOCIETY by depositing their certificates, making proper application, and paying the regular dues.

Section VIII

(1) The Board of Trustees shall appoint such special committees as may seem necessary for the proper conduct of the affairs of this SOCIETY.

(2) All special coöperative committees shall be appointed only on nomination of the Coördinating Service Council.

Section IX

To provide for rotation of the nomiations of Trustees as representatives of the Divisions, as provided in Articles IV and V of the Constitution, some shall be nominated in 1923 to serve portions of the three-year terms as follows:

Terra Cotta to serve three years
Enamel to serve one year
Refractories to serve one year
White Wares to serve two years
Art to serve one year
Heavy Clay Prdoucts to serve three years
Glass to serve two years

Section X

The Board of Trustees shall have power to make any rules not inconsistent with the Constitution and By-laws for the conduct of its business.

BOOK OF STANDARDS TABLE OF CONTENTS

In order that our members may see the scope of the work which has been completed by the Committee on Standards under the direction of A. S. Watts, Chairman of the Committee, the Table of Contents of the Book on Standards is given below. The Book

will be published in the June issue of the *Journal*, so that it will be an integral part of the bound volumes for 1928. Enough additional reprints will be made to supply all persons who are not members, or members who wish additional copies for use.

Supplements to this work will be added each year as the Committee proposes new standards.

I. GENERAL

1. Etymology of "Ceramics"
2. International Atomic Weights
3. Ceramic Raw Materials
4. Pyrometric Cone—Temperature—Time Relation Table
5. Symbols for Heat and Thermodynamics
6. Standard Scales for Testing Sieves

II. STANDARD DEFINITIONS

7. Clay
8. Surface Clay
9. Fire Clay
10. Shale
11. Plastic or Bond Fire Clay
12. Flint Fire Clay
13. Diaspore Clay
14. Nodular Fire Clay
15. Pyrometric Cone Equivalent

III. TENTATIVE DEFINITIONS

16. Spalling
17. Brick
18. Apparent Specific Gravity
19. Bulk Specific Gravity
20. True Specific Gravity
21. High Heat Duty Brick
22. Intermediate Heat Duty Brick
23. Moderate Heat Duty Brick
24. Low Heat Duty Brick

IV. METHODS OF CHEMICAL ANALYSIS

25. Bureau of Standards Method for Fired Refractories
26. A.S.T.M. Method for Refractory Materials
27. Tentative Method for Glass
28. Tentative Method for Sand
29. Determination of Iron in Glass Sands

V. STANDARD SPECIFICATIONS FOR MATERIALS

30. Ceramic Whiting
31. Limestone, Quick Lime, and Hydrated Lime
32. Fire Clay

VI. SPECIFICATIONS FOR MANUFACTURED PRODUCTS

33. Standard Specifications for Plastic Fire Clay Refractories
34. Tentative Specifications for Clay Fire Brick for Malleable Furnaces and Annealing Ovens
35. Tentative Specifications for Clay Fire Brick for Marine Boilers
36. Tentative Specifications for Clay Fire Brick for Stationary Boilers
37. Specifications for Building Brick
38. Specifications for Paving Brick
39. Specifications for Clay Sewer Pipe
40. Specifications and Tests for Hollow Fired-clay Load-bearing Wall Tile
41. Specifications and Tests for Hollow Fire-clay Floor Tile
42. Specifications for Drain Tile

VII. SAMPLING CERAMIC MATERIALS

43. Standard Method for Sampling Ceramic Materials as Delivered
44. Tentative Method for Sampling Clay Deposits

VIII. PREPARATION OF CLAY TRIALS

45. Forming Clay Trials
46. Forming and Handling Clay Test Pieces

IX. STANDARD TEST METHODS

47. Slaking Test
48. Water of Plasticity
49. Shrinkage and Pore Water
50. Drying Shrinkage
51. Pyrometric Cone Equivalent (Softening Point)
52. True Specific Gravity
53. Behavior in Firing of Clay Trials
54. Apparent Porosity of Clay Trials
55. Volume Change
56. Apparent Specific Gravity of Clay Trials
57. Bulk Specific Gravity of Clay Trials
58. Hardness of Clay Trials
59. Absorption
60. Plotting Results of Clay Trials

X. TENTATIVE TEST METHODS

61. Sag Test
62. Transverse Strength
63. Thermal Spalling Action of Clay Fire Brick
64. Load Test of Refractories at High Temperatures
65. Deformation Temperature of Enamels
66. Fineness of Wet Milled Enamel

XI. METHODS OF TESTING ELECTRICAL PORCELAIN

67. Tensile Strength
68. Compression Strength
69. Transverse Strength
70. Resistance to Impact "Pile Driver" Type
71. Dielectric Strength
72. Resistance to Thermal Change
73. Porosity

XII. METHODS OF TESTING BRICK

74. Compression Test
75. Flexure or Cross-Bending Test
76. Rattler Test

XIII. PROCEDURE IN REPORTING TESTS

77. Report Form: Chemical Analysis of Clays, Feldspars, and Flints
78. Report Form: Clay Tests.
79. Report Form: Feldspar and Flint Tests
80. Report Form: Tests of Refractory Clay
81. Report Form: Tests of Manufactured Refractories

XIV. TEST APPARATUS

(Appendix)

A 1. Hydraulic Plunger Piston Press for Forming Clay Trials
A 2. Volumeter: Pycnometer Type
A 3. Volumeter: Overflow Type
A 4. Porosimeter: Employing Liquids
A 5. Porosimeter: McLeod-Gage Type
A 6. Porosimeter: Gas Expansion

A 7. Load Test Furnace and Equipment
A 8. Downdraft Test Kiln and Its Operation
A 9. Updraft Test Kiln and Its Operation
A10. Kiln Fire Box for Oil
A11. Arrangement of Cones, Test Pieces, etc., in Kiln
A12. Impact Testing Machine, Pendulum Type
A13. Sealed-in Mercury Electrode Apparatus for Dielectric Strength Tests
A14. Cross-Breaking (Transverse Strength) Apparatus
A15. Elasticity and Transverse Strength Apparatus
A16. Standard Cone Mold
A17. Impact Strength Apparatus
A18. Thermal Expansion Apparatus
A19. Mechanical Endurance Apparatus
A20. Crushing Strength Apparatus
A21. Viscosity Measuring Apparatus
A22. Test Furnace for Determining P.C.E. Values (Mellon Institute Design)
A23. Orton Electric Test Furnace

PUBLICATIONS OF THE AMERICAN CERAMIC SOCIETY OUT OF PRINT

The following list of *Journals* and *Transactions of the American Ceramic Society* are out of print and not available to persons wishing to purchase complete sets of these publications. The SOCIETY will pay $1.00 a copy for each issue of the *Journal* listed here, which is sent in to the Secretary's office. For the issues of the *Transactions* now out of print, $5.00 per volume will be paid.

Journal of the American Ceramic Society

January, 1924
February, 1924
January 1925
January, 1926
March, 1927

Transactions of the American Ceramic Society

Volume II, 1900
Volume IV, 1902
Volume V, 1903
Volume VI, 1904
Volume VII, 1905
Volume VIII, 1906
Volume IX, 1907
Volume X, 1908
Volume XI, 1909
Volume XII, 1910
Volume XIV, 1912
Volume XV, 1913
Volume XVI, 1914
Volume XVII, 1915
Volume XVIII, 1916
Volume XIX, 1917

CERAMIC EXHIBIT AT SECRETARY'S OFFICE

The office of the General Secretary of the AMERICAN CERAMIC SOCIETY is fast becoming a center of display for many companies manufacturing ceramic ware. The exhibits are placed to good advantage for all to see. And many are the visitors from all over the world who see and admire them.

A sample tea set in white with gold-encrusted border, consisting of tea pot, cream pitcher, sugar bowl, cup, saucer, and plate, has been contributed by Lenox, Inc., Trenton, N. J. Two service plates accompany this set, one valued at $30 and the other at $50.

The Fostoria Glass Co., of Moundsville, W. Va., has an exhibit of four pieces of delicate glassware. A bowl is of pale green, etched on the outer surface. A flat plate with colored border is also of green. Of clear glass with colored border is a stemmed plate of unusual delicacy. An iridescent deep plate with the outer surface etched, completes the exhibit.

Graceful white dancing nymphs in green flower dishes form the center of the group sent by the Cowan Pottery Studio of Rocky River, Cleveland, Ohio. Four candle holders and two vases are also of green.

Paul E. Cox of the Department of Ceramic Engineering of Iowa State College, Ames, Iowa, has five vases on display made by students of his department. Their art is in the lovely shading from blue to rose, and one is decorated by Miss Mary L. Yancey, of the department.

The Bybee Pottery at Lexington, Ky., has a display of seven vases including all the colors in the color circle from yellow to delft blue, and all shapes from small bowls to tall, graceful, handled vases.

Three sectional picnic plates with chocolate cups in three different designs are the contribution from J. C. Montgomery of the Carrollton China Co., Carrollton, Ohio.

Frederick H. Rhead, formerly of the American Encaustic Tiling Co., designed and made the two 29-inch vases which have been on exhibit for more than a year. They are representative of complete control at cone 11 and have a good crystalline glaze.

A group of electrical insulators are the representation of the Westinghouse Electric Co., of East Pittsburgh, Pa.

A white enameled kitchen table with green trim is the exhibit of Pemco from Baltimore, Md. With all its inner edges molded into curves, leaving no deep crevices to catch dust and dirt, it is the newest in sanitary and convenient kitchen ware.

The Robertson Art Tile Co., of Trenton, N. J., has four panels of sample tile. Samples of brick are furnished by two companies; two panels from Claycraft of Columbus, Ohio, and four from the Ava Brick Co. of Ava, Ohio.

Heath Cubes used as paper weights represent the Heath Cube Service of Columbus, Ohio.

Samples of defective glass have been furnished by D. J. McSwiney of Columbus, Ohio, and are of interest to any glass manufacturer.

Many of the Secretary's personal collections are on display in the SOCIETY's general office, each piece representative of some era, development, process, etc. A gem from Bernard Moore, an ancient vase, a plaque of Wedgwood, a large urn from Assyria, and many oddities in clay, glass, and enameled ware are on window sills, desks, cabinets, and shelves, making what is considered a good "study" collection.

The interest shown by visitors in these various displays makes it well worth while for any manufacturer to place an exhibit in this office. Such a display should be indicative of progress in the field of ceramics. The SOCIETY has the beginning of a good library and museum. The members are requested to make contributions to both.

LOCAL SECTION NEWS

Management Meeting in Pittsburgh

The Pittsburgh Section of the AMERICAN CERAMIC SOCIETY, wishing to take advantage of the advances in scientific management and to promote its development in the ceramic industries, is sponsoring jointly with the Management Division of the American Society of Mechanical Engineers, a program on Monday, May 14, at Pittsburgh in connection with the Spring Meeting of the latter Society.

H. M. Kraner of the Westinghouse Electric and Manufacturing Company will read a paper on management problems with reference to high voltage electrical porcelain manufacture and F. H. Hunt of the Rossman Corporation will treat the same subject from the point of view of the manufacture of wall and floor tile. In addition, the meeting will include those interested in other branches of the white ware industry, as well as heavy clay products, glass and enamel, so that the discussion will apply to the ceramic industries generally.

Many other industries will be represented at the meeting by men familiar with and employing interesting wage incentive plans, production control and quality control

plans. The meeting will afford an exceptional opportunity to thoroughly discuss, with experts, the fundamental problems of management with respect to our rapidly developing technology.

Pittsburgh March Meeting

The members of the Pittsburgh Section held a joint meeting on the evening of March 15 with the Pittsburgh Section of the American Chemical Society. The motion picture "The Story of Refractories" was shown at the Bureau of Mines. Following the picture, Francis C. Flint, chief chemist of the Hazel-Atlas Glass Company gave an interesting address on "Recent Developments in the Glass Industry.

California Section Officers

Members of the California section elected the following officers at their recent March meeting: Chairman, Clifford Tillotson; Vice Chairmen, Charles J. Biddle and Paul G. Larkin; Secretary, Franklin A. McCann; Treasurer, Ivan B. Branham, and Councillor, F. B. Ortman.

St. Louis Section Meeting

The members of the St. Louis Section of the AMERICAN CERAMIC SOCIETY held their annual election of officers at their last meeting on March 1. The following officers were chosen to serve for 1928:

Chairman: F. E. Bausch, F. E. Bausch Co., 1605 Chemical Bldg.
Vice Chairman: L. C. Hewitt, Laclede-Christy Clay Products Co., Ambassador Bldg.
Secretary: C. C. Lake, Parker-Russell Mining and Manufacturing Co., 3314 Morganford Rd.
Treasurer: H. W. Perry, Laclede-Christy Clay Products Co.
Chairman, Membership Comm.: H. B. Stone, Evens & Howard Fire Brick Co.
Chairman, Program Comm.: J. L. Crawford, Laclede-Christy Clay Products Co.
Chairman: Executive, Comm.: F. E. Bausch.
Nominations: F. E. Bausch and L. C. Hewitt.

Through the courtesy of the Norton Company the motion picture "The Age of Speed" was presented, depicting the manufacture and uses of abrasives. F. K. Pence of Paducah, Ky. led the discussion.

Arrangements were made for a trip to the Rolla School of Mines at Rolla, Mo. in April.

Those who attended this meeting were:

A. W. Buckingham, Russell Engineering Co.
Fred H. Schwetye, Parker-Russell M. M. Co.
Aug. Vollmer, Jr., St. Louis Pottery & Mfg. Co.,
H. W. Perry, Laclede-Christy Clay Products Co.
Joseph Early.
Edward Volz, Evens & Howard Fire Bk. Co.
H. B. Stone, Evens & Howard Fire Bk. Co.
J. L. Crawford, Laclede-Christy Clay Products Co.
C. H. Blank, Laclede-Christy Clay Products Co.
F. K. Pence, Paducah Tile & Pottery Co.
F. E. Bausch, Frederick E. Bausch.
Foster Holmes, Evens & Howard Fire Bk. Co.
L. C. Hewitt, Laclede-Christy Clay Products Co.
J. B. Lyon, Laclede-Christy Clay Products Co.
W. F. Godejohn, Laclede-Christy Clay Products Co.
J. W. Bull, Laclede-Christy Clay Products Co.
Edw. R. Walsh, Laclede-Christy Clay Products Co.
L. H. Blue, Laclede-Christy Clay Products Co.
J. Groppe, Highland Fire Clay Co.
G. W. Parker, Parker-Russell M. M. Co.
C. C. Lake, Parker-Russell M. M. Co.

NOTES AND NEWS

NOTES FROM THE CERAMIC SCHOOLS

Alfred University Student Branch

The Student Branch of the AMERICAN CERAMIC SOCIETY at the New York State School of Clayworking and Ceramics started the second semester of the school year with a drive for membership. At present the membership is more than one hundred and includes nearly all ceramic students. The freshman were also invited to affiliate. The Student Branch meets biweekly with a speaker on ceramic subjects or a ceramic industrial film for its feature.

Prof. Fosdick recently lectured before the members of this group.

The New York State School of Clayworking and Ceramics is the home of one of the chapters of the new national ceramic engineering fraternity, Beta Pi Kappa. The fraternity was founded at the convention by the union of Beta Pi Kappa of North Carolina State College and Delta Pi Alpha of New York, both local ceramic fraternities. The purposes of the fraternity are to form a more common bond between engineers graduating from different schools and to create better interest and a higher standard of scholarship in ceramic work. The president of the new fraternity is A. M. Greaves-Walker.

University of Oklahoma Ceramic Work

John N. Frank, head of the ceramic department at the University of Oklahoma, Norman, Okla., is presenting ceramic work under a course in pottery. There are three semesters of work offered, each being an advance on the other, and each a three to five semester-hour course. The first semester includes hand building, wheel work, simple mold work, casting, and glazing. The second includes more wheel work, more complicated molds, advanced designing and decorating of pieces, and glaze theory. The third course, which has not yet been offered, will be in making such pieces as tea-tables, fire-places, small fountain tiles, wall panels, and many such problems, and orginating all glazes and some clay bodies.

At present the course is presenting only art pottery, under the School of Painting and Design, but the work is established as a ceramic department of the University. Later, when the department grows and more equipment can be afforded, it is the intention of the department to go into the building materials, chiefly with the idea of developing the state's clay.

At present Prof. Frank is the only instructor in the department.

The equipment consists of a #102 Keramic Studio Kiln, 2 potter's wheels, a small ball mill, and a butter churn used to mix the clay, and other minor equipment. The class room is 15 by 45 feet and the store is about 15 feet square.

Nineteen students were enrolled the first semester and fifteen the second semester.

Pottery Course at University of Washington

The College of Fine Arts, University of Washington, has had a pottery course for over six years. Mrs. Eugenia Worman is the instructor and teaches art pottery design and education. The class averages about 24 girls for two quarters each year and the size of the class room is the main cause of restricted growth.

Dudley Pratt is the instructor in sculpturing. Both the pottery and sculpturing classes do their work in the Mines Hall. The ceramic engineering department only coöperates by providing them with room and some of the materials and the ceramic boys fire the ware for them. Some semitechnical manufacturing or glaze-color work will be organized in the near future. The class in sculpturing numbers about twenty members.

AMERICAN REFRACTORIES INSTITUTE MEETING

The American Refractories Institute Annual Meeting and Golf Tournament will be held May 8 and 9, at Green Brier, White Sulphur Springs, W. Va. Business and technical sessions will be held the first day followed by the tournament. Election of officers and directors will also be held at this meeting.

MATERIALS HANDLING DIVISION, A.S.M.E.

The Materials Handling Division of the American Society of Mechanical Engineers will hold a national meeting in Philadelphia on April 23 and 24. A cordial invitation has been extended to the members of the AMERICAN CERAMIC SOCIETY to attend this meeting.

On Monday morning, April 23, at the Foundry Session, two remarkable systems of handling installed in steel and cast-iron foundries will be presented. The afternoon will be spent in plant inspection tour and at the informal dinner in the evening, speakers of national prominence will speak on materials handling.

The Tuesday morning session will be taken up with a discussion on "External Handling and Transport." In the afternoon papers will be presented on interior handling, production control by handling and exterior bulk handling at plants and terminals. Tuesday evening will be a joint meeting with the National Coal Association and the American Institute of Mining and Metallurgical Engineers, on the "Mechanization of Coal Mines."

LIME CONVENTION TO DISCUSS CRITICAL CONDITIONS

The 1928 Convention of the National Lime Association is to be held at the Belmont Hotel in New York City on May 23–24. The most emphatic note in the announcement is that this is to be a convention of the industry, rather than of the Association, thus recognizing the sound principle that the industry must be given a time and place to discuss the critical conditions which lost over three million dollars last year, with a decrease of over two hundred thousand tons in production.

To carry out this purpose there is to be no program for the Convention, and no cut-and-dried plan to be offered for acceptance. Members and others are submitting

quesions bearing directly upon conditions which prevail in various sections of the country, and these questions will serve as the basis of a free-for-all Round Table Discussion. It is hoped by all, members and nonmembers, that this discussion will form some constructive plans to put the industry upon a sound basis.

In order to remove all suggestion of formality and predetermined conclusions, the Chairmanship of the Convention has been given to one chosen for his appreciation of present conditions and his freedom from any part in the controversies which prevail. This is the request of J. F. Pollock, Chairman of the Board, and expresses the desire of the Board for a strictly open meeting. The Chairman will be S. W. Stauffer, of the J. E. Baker Company, at York, Pennsylvania. Every one present will have an opportunity to talk, as long as his remarks bear upon the real problems of the industry.

In order that there shall be no restraint whatever, and that the discussion may be strictly free, barring improper matters, the Convention will not be reported for the publishing of proceedings.

CLAY PRODUCTS FOREMEN'S SHORT COURSE

A Clay Products Foremen's Short Course was held at Iowa State College on March 7–9, 1928. The lectures presented at this course were:

(1) "Electrical Equipment," by V. L. Hein, Engineering Extension Department.

(2) "Fuels," by A. K. Friedrich, Mechanical Engineering Department.

(3) Discussion on "Your Own Troubles with Firing," led by D. A. Moulton, Ceramic Engineering Department.

(4) "Air Moving Machinery," by R. A. Norman, Mechanical Engineering Department.

(5) "Some Advantages of the Time Study Work," by R. E. Roudebush, Mechanical Engineering Department.

(6) Discussion on "Your Own Troubles with Drying," led by D. A. Moulton.

(7) "Roofing Tile and High Temperature Cement," by D. A. Moulton.

A.S.M.E. SPECIAL RESEARCH COMMITTEE ON FUELS

Proposed Program

Consideration of the tremendous possilibilities that are dependent upon a greater and more exact knowledge of fuels, their constitution, production, utilization, and the economics of their distribution and use, has caused The American Society of Mechanical Engineers to take definite steps toward the correlation and extension of fuel research.

In October 1927, a "Special Research Committee on Fuels" was appointed and authorized to collect existing data on Fuels Research, coördinate present research efforts where possible and advisable, and carry on research on specific problems in this field. The Special Committee had its organization meeting during the annual convention of the Society in December 1927, when permanent officers were elected and working plans were decided upon.

The membership and officers of the Special Committee, as permanently organized, are as follows:

Chairman, F. R. Wadleigh, Consulting Engineer
Vice-Chairman, A. C. Fieldner, Chief Engineer, U. S. Bureau of Mines
Secretary, Vincent G. Shinkle, Consulting Petroleum Engineer
W. H. Blauvelt, Consulting Engineer
S. B. Flagg, Fuel Engineer, Electric Bond & Share Co.

W. H. Fulweiler, Chemical Engineer, The U.G.I. Contracting Co.
R. T. Haslam, Technical Advisor, Standard Oil Development Co.
J. H. McNally, Fuel Engineer, Pardee Brothers & Co., Inc.
W. L. Robinson, Supt. Fuel & Locomotive Performance Baltimore & Ohio Railroad Co.
Walter Runge, International Combustion Engineering Corp.
W. Trinks, College of Engineering, Carnegie Institute of Technology
W. J. Wohlenberg, Associate Professor of Mechanical Engineering, Sheffield Scientific School, Yale University.
H. C. Porter, Consulting Chemical Engineer

It is believed that the Committee, as constituted, is a strong, well-balanced one; its members, all of them well-known, were especially chosen for their familiarity with both technical and practical fuel problems.

The general plan, as presented to and approved by the Main Research Committee, is as follows:

(1) Title

"Research in Fuels" to be carried on by a special research committee of the A.S.M.E. and to be known as the "A.S.M.E. Special Research Committee on Fuels."

(2) Scope and Purpose of Research

(*a*) The gathering and correlation of results obtained and of studies being pursued, in fuel research, with the idea of making known and available, as far as possible, the progress made and the different phases under investigation.

(*b*) The direction, to such extent as may be possible and advisable, of the lines of fuel research being and to be pursued, with the adoption of plans for carrying them on.

(*c*) The development and conduct of definite research projects in fuels which will involve the selection of personnel and facilities for research and the securing of necessary funds for the carrying on of such projects.

(3) Value to Industry

Research in fuels is so broad, complicated, and important, both to industry and the profession, that the scope and purpose of the recommended project, as outlined in (2) would be of immense value, if carried out.

The committee suggested that, acting as a neutral medium between all groups, producers, distributors, and consumers, it could be the means of: (*a*) securing all existing fuels research data, (*b*) making it available to those interested, (*c*) focusing attention upon fuels research projects that are being studied or that need investigation, and (*d*) sécuring the necessary aid for carrying on various research projects, as deemed advisable.

(4) Procedure

The committee suggested should be divided into several groups; each group to handle one of the specific general directions to its particular research program.

The specific general subjects that have been recommended for research are: (*a*) The Constitution of Coal, (*b*) The Carbonization of Coal, (*c*) The Preparation of Coal, (*d*) Coal Utilization and the Abatement of Waste in Use.

As preliminary to organizing actual research work, the Committee, at its first meeting, recognized the necessity for and value of obtaining exact and definite knowledge regarding research work now being carried on or planned and decided to assign to each member the work of securing the desired information regarding his particular field, as included in the broad, general subjects for research determined upon. The tentative assignment of members to specific subjects is as follows:

Subject	Member
(1) The Constitution of Coal	A. C. Fieldner
(2) High Temperature Carbonization of Coal	W. H. Blauvelt
(3) Low Temperature Carbonization of Coal	Walter Runge
(4) Complete Gasification of Coal	W. H. Fulweiler
(5) Other Methods of Processing Coal	H. C. Porter
(6) Combustion in Domestic Furnaces (all fuels)	J. H. McNally-F. R. Wadleigh
(7) Combustion in Central Power Stations (all fuels)	S. B. Flagg-W. J. Wohlenberg
(8) Combustion in Locomotive Furnaces (all fuels)	W. L. Robinson
(9) Combustion in Metallurgical and Industrial Furnaces (all fuels)	W. Trinks
(10) Preparation of Coal	J. H. McNally-F. R. Wadleigh
(11) Petroleum Products as Fuel; Processes and Use; Their Economic Relationships to Other Fuels	R. T. Haslam-Vincent G. Shinkle

After the available data have been secured, as outlined, the Committee purposes to decide upon the actual research activities to be inaugurated with plans for carrying them on and for securing the necessary personnel, funds, and facilities.

At this time, it is desired to bring the whole matter to the attention of all interested in fuels research, *i.e.*, producers, users, and the technical schools, as well as those concerned with research generally.

The subjects chosen and their ramifications embrace scientific, "pure" research, as well as utilization research, and are of great importance to science and industry.

The fuels field is a very broad, complicated, and important one, and a program such as the Committee is working on is greatly needed. While a large amount of research in fuels has been and is now being done, both in this country and abroad, by engineering schools, technical organizations, governmental bureaus, and industry, there is a great deal of duplication and waste. Correlation of existing information is, therefore, of first importance in approaching this subject of fuels research.

SMOKESTACKS IN UTAH

R. A. Hart, Secretary of the Western Clay Products Association, and member of the American Ceramic Society issues the *Pyrogram*, as the monthly official organ of the Association. This month the following information on smokestacks is presented:

The earlier major smokestacks in Utah, as elsewhere, were constructed largely of brick or of fired clay special chimney blocks, and there are many interesting examples of such structures to be seen in many portions of the state. Of particular interest are the old smelter stack, northwest of Salt Lake City, built in 1894 and still in perfect condition; the stack at the Provo Tabernacle, which is a striking example of the decorative possibilities of common brick construction; the stack at the old A. S. & R. smelter at Murray; the stacks at several of the operating smelters, particularly notable for their great heights; the stack at the Salt Lake City station of the D. & R. G. W. Railway, which is so illustrative of the desirability of architectural harmony; and numerous other stacks.

For several years the construction of smokestacks of substitute materials had quite a vogue. This vogue has passed in the East and there is a strong tendency here to return to the former higher standards.

There was no particular reason for the vogue. It did not mean that there was any demerit in stacks built of brick or clay blocks; indeed stacks built of substitute materials had to be lined with clay ware in order properly to fulfill their requirements.

Fired clay is an ideal material for smokestacks and chimneys, being unaffected by heat or cold and not being susceptible to deterioration through the effects of acids or alkalis or of moisture.

Structurally, the small units of fired clay, whether brick or block or radial tile, not only provide ample strength and stability, but afford the very necessary flexibility to take up the many and complex stresses resulting from wind action, temperature changes, and other disturbing influences.

The importance of architectural harmony has not been realized fully always and there are numerous examples of fine brick structures, beautiful with respect to color and texture of the walls, in which the harmony has been marred by the introduction of a smokestack of substitute material.

It is urged that more thought be given to the matter of architectural harmony and it is believed that, with the superiority of fired clay as a material, and the structural superiority of its units, the utmost in satisfaction will be realized in the use of brick or clay blocks for such structures.

CALENDAR OF CONVENTIONS

AMERICAN CERAMIC SOCIETY		
Annual Meeting	Feb. 1929	Chicago, Ill.
Ceramists' Tour Abroad	May 19–July 5	
Amer. Chemical Society	April 16–20	St. Louis, Mo.
American Electrochemical Society		
(Spring Meeting)	April 26–28	Bridgeport, Conn.
(Fall Meeting)	Sept. 20–22	Charleston, W. Va.
Amer. Foundrymen's Assn.	May 14–18	Philadelphia, Pa.
Amer. Gas Assn. (Natural Gas Dept.)	May	Dallas, Texas
Amer. Institute of Architects	May 9–11	St. Louis, Mo.
Amer. Refractories Inst.	May 8–9	White Sulphur Springs, W. VA.
Amer. Soc. Mechanical Engineers		
(50th Anniversary)	April 7	Washington, D. C.
(Spring Meeting)	May 14–17	Pittsburgh, Pa.
(Regional)	Aug. 27–29	St. Paul-Minneapolis
(Regional)	Oct. 1–3	Boston, Mass.
Amer. Soc. Steel Treating		
(Annual Meeting)	Oct. 8–13	Philadelphia, Pa.
Amer. Zinc Institute	April 16–18	St. Louis, Mo.
Assn. of Sci. App. Makers of Amer.	May 5–7	Alantic City, N. J.
Canadian Natl. Clay Products Assn.	June 11–13	Montreal, Quebec
Mfg. Chemists Assn. of U. S.	June 2	New York City
Natl. Acad. of Sciences	April 23–25	Washington, D. C.
Natl. Assn. of Mfgrs.	October	
Natl. Assn. Mfgrs. Heating and Cooking Appliances	May 9–10	Detroit, Mich.
Natl. Clay Prod. Ind. Assn.	April	Chicago, Ill.
Natl. Lime Assn.,	May 23–24	New York City
Optical Soc. of Amer.	October	Washington, D. C.
Safety Congress	Oct. 1–5	New York City

CORRECTION

On page 56, March *Bulletin*, under "Officers of the AMERICAN CERAMIC SOCIETY," the address of F. A. Harvey is incorrectly given. This should read, "F. A. Harvey, Harbison-Walker Refractories Company, Farmers Bank Building, Pittsburgh, Pa."

WHAT further consideration have you given to the European Tour?

IF you are still undecided after having talked with the representatives at Atlantic City, decide now to go.

PLANTS are open to the tour members which would be opened only after negotiations with the directors.

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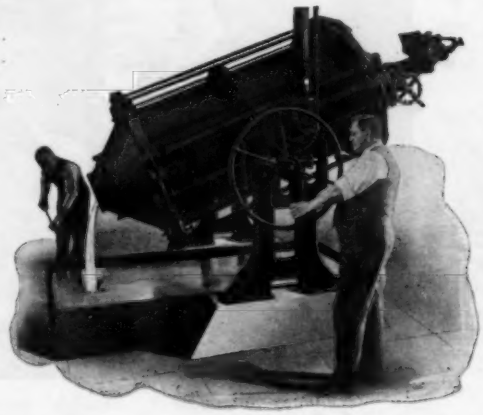

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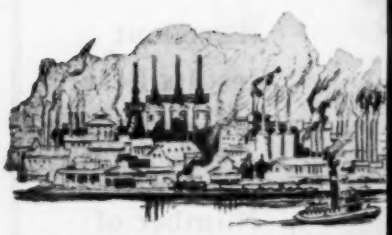
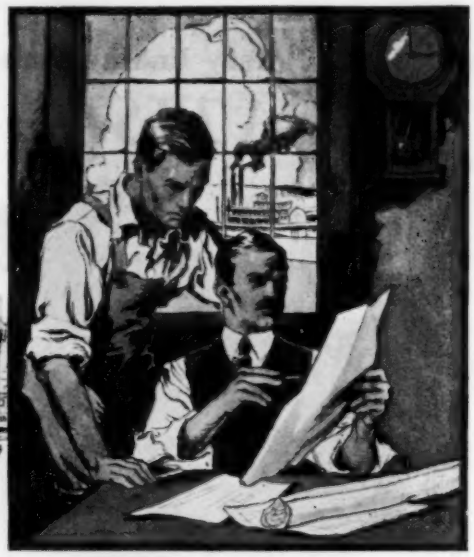


Today that little plant which was started almost twenty-eight years ago is an organization representing more than $100,000,000—the largest manufacturer of special analysis iron and steel sheets in the world.



Putting a new idea to work

ABOUT twenty-eight years ago two young men were running a little sheet metal business near one of the docks along the Ohio River in Cincinnati. They were corrugating galvanized sheet metal for roofing and siding and also forming gutters, leaders, and downspouts.

Then said one of the men, "Here we are trying to build up a high-grade business, but we get our sheets from one plant, they are galvanized in another, and we finally form them. If we expect to build up a quality sheet metal business, we must bring all these activities under one roof. And if we expect to get the quality we want, we must make our own steel and have our own mills to roll the sheets and galvanize them before forming."

Here, then, was a new idea—the consolidation and co-ordination of different processes—and they began to lay plans. They secured a little capital, bought rolling mill equipment and started a small steel works and sheet mill at Middletown, Ohio. In this mill they melted the iron, rolled it into bars, then into sheets. The sheets were then galvanized and corrugated into roofing, siding, guttering, leaders and downspouts.

Time went on. The business grew. Gradually ore mines were secured, blast furnaces were built, coal mines and coke ovens were also brought under control. The old plant was enlarged and a much bigger new plant built.

Today that little plant which was started almost twenty-eight years ago is an organization representing more than $100,000,000—the largest manufacturer of special analysis iron and steel sheets in the world. It represents the development and unfolding of the idea for a quality product that came to two men while they were working in their little shop alongside the Ohio River docks.

Back of every big business is an idea. The American Rolling Mill Company started with the idea of the conservation of metals through the manufacture of a better grade of sheet metal. The thought of quality lay back of every move in the production of Armco Ingot Iron.

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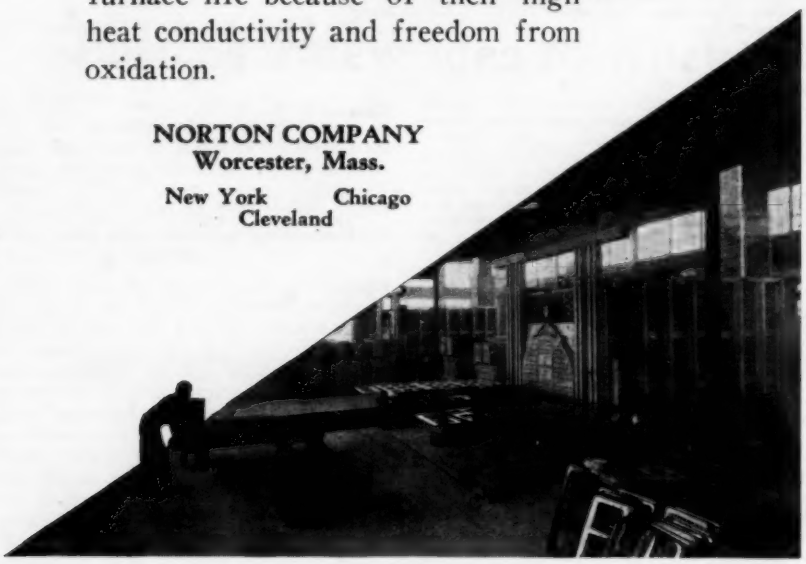

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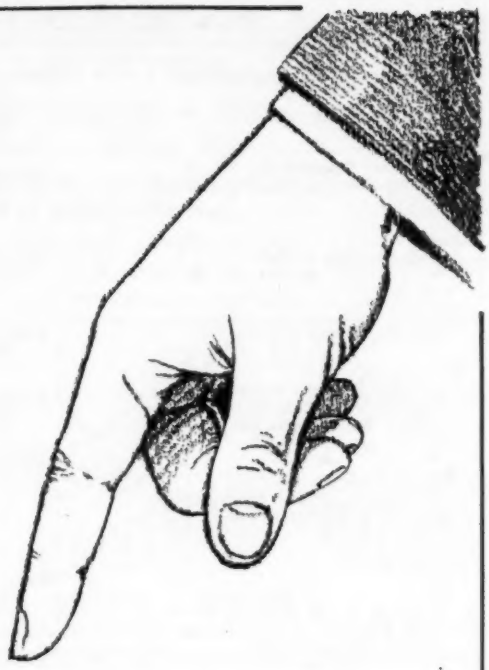

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	Page
Abbé, Paul O.	33
American Gas Association	4B
American Potash and Chemical Corp.	18
American Rolling Mill Co.	12
Brown Instrument Co.	6
Carborundum Co.	3
Chambers Brothers Co.	34
Chicago Vitreous Enamel Product Co.	35
Classified Advertising	30
Drakenfeld and Co., B. F., Inc.	22
Edgar Brothers Co.	20
Engelhard, Chas., Inc.	4
Eureka Flint & Spar Co.	34
Exolon Company	24
English China Clays Sales Corp.	39
Ferro Enamel Supply Co.	18
Fisher Governor Co.	5
Fisher Scientific Co.	Inside Back Cover
General Electric Co.	37
Harbison-Walker Refractories Co.	33
Harshaw, Fuller and Goodwin Co.	8
Harrop Ceramic Service Co.	18
Innis, Speiden & Co., Inc.	26
Jeffrey Mfg. Co.	2
Journal of the Society of Glass Technology	30
Jungmann & Co.	26
Kentucky-Tennessee Clay Co.	33
Lake County Clay Co.	20
LaMotte Chemical Products Co.	35
Leeds and Northrup Co.	1
Maxon Premix Burner Co.	26
McDanel Refractory Porcelain Co.	18
Metal & Thermit Corp.	Outside Back Cover
Montgomery Porcelain Products Co.	34
Mueller Machine Co.	38
National Silica Co.	16
Norton Co.	14
Old Hickory Clay & Talc Co.	35
Pacific Coast Borax Co.	24
Pennsylvania Pulverizing Co.	36
Pennsylvania Salt Mfg. Co.	18
Philadelphia Drying Machinery Co.	40
Potters Supply Company	16
Proctor and Schwartz, Inc.	31
Professional Directory	32
River Feldspar Co.	24
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Spinks, H. C. Clay Co.	28
Titanium Alloy Mfg. Co.	Center of Book 10
Tyler, W. S., Co.	38
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U. S. Smelting Furnace Co.	11
Vitro Manufacturing Co.	36

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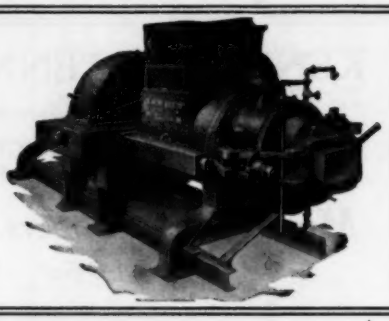

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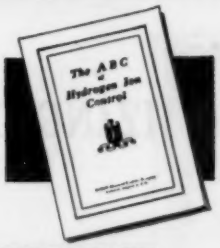

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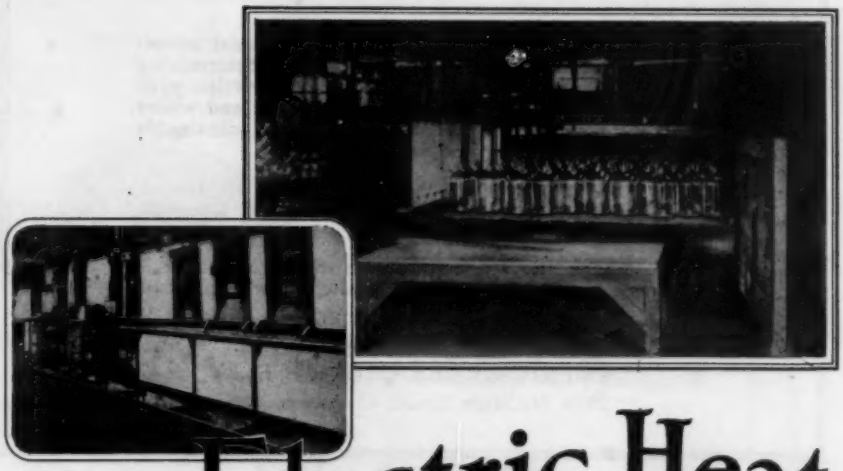

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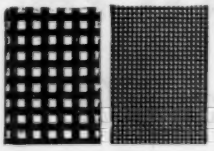

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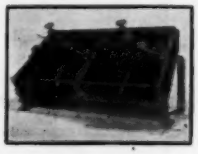

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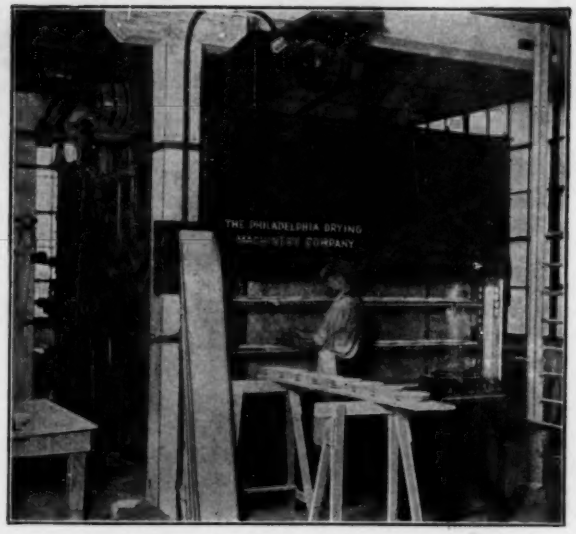

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Slight variations in free soda, free oxide of antimony, and in minor impurities produce marked variations in the color and lustre of enamels.

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—is made by our own special process with strict technical control of each step, and each lot is subjected to exacting chemical and physical tests before it is barreled.

Furthermore, owing to a characteristic size and grain of material obtained by our process of manufacture, a more dense and more uniform opacity is obtained than by any other make.

Metal & Thermit Corporation

Ceramic Department

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